Brown AND Caldwell

Prepared for Valley Water

Final Countywide Water Reuse Master Plan

(CoRe Plan)

June 2021

Table of Contents

Acknowledgements........vii

Preface: A Living Document........x

Executive Summary........1

Section 1: Introduction........8

1.1 One Water Approach........8
1.2 Water Supply Planning........9
1.3 CoRe Plan Goals and Objectives........10

Section 2: Partnerships and Engagement........14

2.1 Reuse Roles and Responsibilities within Santa Clara County........16
2.2 Relevant Institutional Arrangements........18

Section 3: Regulatory Framework........20

3.1 Regulators and Respective Purviews........20
3.2 Independent Advisory Panel........22
3.3 Non-Potable Reuse (Recycled Water)........22
3.4 Potable Reuse........23

Section 4: Existing Reuse Systems........26

4.1 System Characteristics........28
4.2 Existing Flow Conditions........29
4.3 Reuse Research Facilities........31

Section 5: Expanded Reuse Potential........32

5.1 Projected NPR Demands........32
5.2 Available Source Water for Potable Reuse........34
5.2.1 SJ/SC RWF Flow Analysis........35
5.2.2 Palo Alto RWQCP Flow Analysis........35
5.2.3 Sunnyvale WPCP Flow Analysis........36
5.2.4 SCRWA WWTP Flow Analysis........37
5.2.5 Summary........37
5.3 Onsite Reuse Considerations........38

Section 6: Project Portfolios........40

6.1 Conceptual Alternatives/Portfolios........40
6.2 Feasible Portfolios........41
6.2.1 San José (SJ) Portfolio........42
6.2.2 Palo Alto and Sunnyvale Combined-Flow Regional AWPF for GWR........47
6.2.3 Palo Alto/Sunnyvale (PA/SV) Two Separate AWPFs for GWR........50
6.3 South County Reuse Options........52
6.4 At-a-Glance Comparison of Portfolios/Options and Cost Estimates........58
6.5 Evaluation and Risk........63

6.5.1 Evaluation Tool 63
6.5.2 Risk Tool...64
6.5.3 ROC Management Strategies Evaluation 65
Section 7: Potential Future Opportunities and Alternative Elements..67
7.1 NPR/NPR+ Expansion (featured in all portfolios) 67
7.2 Interties between Recycled Water Systems..69
7.3 Potential Future Reuse Opportunities, Design Variations, and Alternative Elements 71
Section 8: Implementation Planning 73
8.1 Regulatory Compliance Considerations 73
8.1.1 Regulatory Compliance Evaluation 75
8.1.2 Recommended Next Steps for Regulatory Compliance...76
8.2 Rate Impacts...77
8.3 Public Outreach and Engagement 77
8.4 Partnerships and Governance..80
8.5 Policy Issues..82
8.6 Environmental Review and Documentation..83
8.7 Program Funding...83
8.8 Implementation Next Steps, Opportunities, and Challenges...84
Section 9: Flexible Implementation Scenarios 88
9.1 Context...88
9.2 San José Flex Scenarios 90
9.3 Palo Alto Flex Scenarios..92
9.4 Flex Scenario Costs 94
9.5 Pipeline Sizing Cost Evaluation...97
9.6 Considerations for Next Steps...99
Section 10: Appendices List 100
Section 11: References 101
Glossary 103
Abbreviations 111

List of Figures

Figure ES-1. Example of risk assessment tool results to compare CoRe portfolios and options 4

Figure ES-2. Conceptual overview of flexible implementation scenarios 6

Figure 1-1. Valley Water's One Water Plan as a Countywide framework 8

Figure 1-2. Partner Agencies' sewersheds contributing flow to each of the four WWTPs 13

Figure 2-1. Blueprint for robust engagement and collaboration at multiple levels across various groups to inform the CoRe Plan development 14

Figure 2-2. Current roles and interagency relationships supporting reuse throughout the County 17

Figure 3-1. California regulations address five specific approaches to potable reuse 24

Figure 4-1. Existing recycled water distribution systems, water/recycled water retailer service areas, and sewershed boundaries throughout Santa Clara County 27

Figure 4-2. Existing flow conditions by Partner Agency, based on daily WWTP influent flows (2014 through 2019) 29

Figure 4-3. Existing NPR demands by Partner Agency, based on average monthly use (2015-2017) 30

Figure 4-4. Key results of the PR demonstration test plan for SVAWPC 31

Figure 5-1. Typical WWTP flow balance 34

Figure 5-2. Projected flow conditions at SJ/SC RWF considering future influent projections and SBWR NPR+ demands 35

Figure 5-3. Projected flow conditions at Palo Alto RWQCP considering future influent projections and Palo Alto/Mountain View NPR+ demands 36

Figure 5-4. Projected flow conditions at Sunnyvale WPCP considering future influent projections and NPR demands 36

Figure 5-5. Projected flow conditions at SCRWA's WWTP considering future influent projections and South County RWS NPR demands 37

Figure 5-6. Anticipated outcomes and impacts of onsite non-potable reuse systems in Santa Clara County 39

Figure 6-1. Portfolio 1a: SJ GWR facility locations and pipeline alignments 45

Figure 6-2. Portfolio 1b: SJ RWA facility locations and pipeline alignments 45

Figure 6-3. Portfolio 1c: SJ TWA (Milpitas pipeline) facility locations and pipeline alignments 46

Figure 6-4. Portfolio 1d: SJ TWA (new pipeline) facility locations and pipeline alignments 46

Figure 6-5. Portfolio 2a: PA (+SV) GWR facility locations and pipeline alignments 49

Figure 6-6. Portfolio 2b: SV (+PA) GWR facility locations and pipeline alignments 49

Figure 6-7. Portfolio 4: PA/SV GWR facility locations and pipeline alignments 51

Figure 6-8. MH-1 (NPR+) facility locations and pipeline alignments 55

Figure 6-9. MH-2 (GWR) facility locations and pipeline alignments 56

Figure 6-10. MH-3 (SWA) facility locations and pipeline alignments 57

Figure 6-11. Ranges of estimated capital costs with AACE Class 5 level of accuracy 59

Figure 6-12. Ranges of estimated annual O&M costs with AACE Class 5 level of accuracy 60

Figure 6-13. Levelized unit costs with AACE Class 5 level of accuracy (30-year and 100-year life cycles) 61

Figure 6-14. Example of risk assessment tool results to compare CoRe portfolios and options... 64

Figure 7-1. Potential future recycled water distribution system expansions throughout Santa Clara County and water retailer service areas 68

Figure 7-2. Potential interties between recycled water systems... 70

Figure 8-1. Summary of relevant regulations, permits, and required documentation for non-potable and potable reuse 74

Figure 8-2. External triggers and subsequent steps for implementing Countywide reuse 85

Figure 9-1. Conceptual overview of flexible implementation scenarios.. 88

Figure 9-2. Assumed source water flow rates and production capacities for flex implementation of a San José-based AWPF 90

Figure 9-3. Flexible implementation from San José-based AWPF: RWA Flex facility locations and pipeline alignments....... 91

Figure 9-4. Flexible implementation from San José-based AWPF: TWA Flex facility locations and pipeline alignments 91

Figure 9-5. Assumed source water flow rates and production capacities for flex implementation of a Palo Alto-based AWPF 92

Figure 9-6. Flexible implementation from San José-based AWPF: RWA Flex facility locations and pipeline alignments 93

Figure 9-7. Flexible implementation from San José-based AWPF: TWA Flex facility locations and pipeline alignments........ 93

Figure 9-8. Estimated capital costs of flexible implementation scenarios 95

Figure 9-9. Estimated O&M costs of flexible implementation scenarios 96

Visual Glossary-1. Types of reuse explored for Valley Water's CoRe Plan 104

Visual Glossary-2. The capability of public water systems to protect public health through long-term sustainability and regulatory compliance requires TMF capacity 108

Visual Glossary-3. Santa Clara County general location, groundwater subbasins, and existing water/wastewater treatment facilities.. 110

List of Tables

Table ES-1. Programmatic Approach for Evaluating Reuse Opportunities 3

Table 2-1. Valley Water's Responsibilities as a Leader and Partner Advancing Countywide Reuse 16

Table 5-1. Summary of Projected Long-Term NPR Demands by Recycled Water System 33

Table 5-2. Potential Annual Yield for Potable Reuse Considering Source Water Availability by Producer........ 37

Table 6-1. Programmatic Approach for Evaluating Reuse Opportunities 41

Table 6-2. Portfolio 1a (SJ GWR) Key Features and Costs 42

Table 6-3. Portfolio 1b (SJ RWA) Key Features and Costs 43

Table 6-4. Portfolio 1c (SJ TWA, Milpitas Pipeline) Key Features and Costs........ 43

Table 6-5. Portfolio 1d (SJ TWA, new pipeline) Key Features and Costs 44

Table 6-6. Portfolio 2a (PA [+SV] GWR) Key Features and Costs........ 47

Table 6-7. Portfolio 2b (SV [+PA] GWR) Key Features and Costs........ 47

Table 6-8. Portfolio 4 (PA/SV GWR) Key Features and Costs 50

Table 6-9. Potential Future South County Reuse Opportunities 52

Table 6-10. MH-1 (NPR+) Key Features and Costs 53

Table 6-11. MH-2 (GWR) Key Features and Costs 53

Table 6-12. MH-3 (SWA) Key Features and Costs........ 54

Table 6-13. Estimated Portfolio Costs and ROC Management Options........ 62

Table 6-14. Criteria and Sub-criteria Built into the CoRe Evaluation Tool 63

Table 6-15. Overview of ROC Management Strategies Evaluation Prepared by GHD (Valley Water, 2020a)........ 66

Table 7-1. Summary of Potential Recycled Water System Interties........ 69

Table 8-1. Regulatory Complexity related to Public Health Considerations in the Potable Reuse Portfolios........ 75

Table 8-2. Regulatory Complexity related to Discharge of Purified Water to the Environment in the Potable Reuse Portfolios........ 76

Table 8-3. Implementation Challenges........ 86

Table 9-1. Estimated Conveyance Costs under Various Scenarios for Purified Water Pipeline Diameter from AWPFs in San José or Palo Alto to LGRP........ 98

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After three years of collaborative effort and dedication, the Countywide Water Reuse Master Plan (CoRe Plan) is an example of applying innovative thinking to inform pivotal vision and direction related to exploring future potable reuse opportunities through integrated, regional efforts. The CoRe Plan reflects valuable contributions from many entities, organizations, and individuals working together toward a shared goal for the future. Without the contributions and collaboration of those listed here, this work would not have been possible.

Valley Water Teams

Core Project Team: Recycled and Purified Water Unit

Hossein Ashktorab	Unit Manager, Executive Sponsor
Miguel Silva	Project Manager (PM)
David Tucker	Assistant PM

Under the direction of:

Enrico (Rick) Callender	Chief Executive Officer
Aaron Baker	Chief Operating Officer, Water Utility
Vincent Gin	Deputy Operating Officer, Water Supply Division
Kirsten Struve	Assistant Officer, Water Supply Division

Valley Water Technical Review Team

Anthony Mendiola
Bhavani Yerrapotu
Darin Taylor
Eric Olson
George Cook
Gina Adriano
Henry Barrientos
Jason Chiar
Jeannine Larabee
Luisa Sangines
Medi Sinaki
Metra Richert
Neeta Bijoor
Samantha Greene
Taylor Lipps
Vanessa De La Piedra
Zachary Helsley

Other Contributors

Apollonia Ross
Ava Bobby
Bassam Kassab
Calvin Nguyen
Erin Baker
Garth Hall
Helen Hoang
Jerry De La Piedra
Katrina Jessup
Keila Cisneros
Kristen Lester
Linzi Bhatta
Luis Jaimes
Melene Agakanian
Nina Hawk
Norma Camacho
Paolo Baltar
Serena Desai

Board of Directors

John L. Varela	District 1
Barbara Keegan	District 2
Richard P. Santos	District 3
Linda J. LeZotte	District 4
Nai Hsueh	District 5
Tony Estremera, Chair	District 6
Gary Kremen, Vice Chair	District 7

Project Partners

City of Morgan Hill

Anthony Eulo
Chris Ghione
James Sylvain

City of Gilroy

Karl Bjarke
Saeid Vaziry

City of San José

Amit Mutsuddy
Henry Louie
Jeff Provenzano
Kerrie Romanow
Pedro Hernandez

City of Santa Clara

Gary Welling
Shilpa Mehta

City of Palo Alto

Diego Martinez Garcia
Karin North
Karla Dailey
Lisa Bilir
Phil Bobel
Samantha Engelage

City of Mountain View

Ankit Sharma
Elizabeth Flegel
Lisa Au
Nirmal Sajjan
Salman Hosseini

City of Sunnyvale

Bryan Berdeen
Mansour Nasser
Ramana Chinnakotla
Steve Hogg

San Francisco Public Utilities Commission (SFPUC)

Manisha Kothari
Paula Kehoe

Other Contributors

Alison Turner
Dan Repp
Girum Awoke
Gregg Hosfeldt

Independent Advisory Panel

Panel Members

Adam Olivieri, Dr.P.H., P.E. (Co-Chair)
James Crook, Ph.D., P.E., BCEE (Co-Chair)
Jean Moran, Ph.D.
Katherine Cushing, Ph.D.
Mehul Patel, P.E.
Shane Snyder, Ph.D.

Other Contributors

Kevin Hardy
Suzanne Sharkey

Consultants

Brown and Caldwell	Project Role
Jenny Gain, P.E.	Consultant Team Project Manager
Julia Schmitt, P.E.	Deputy Project Manager
Wendy Broley, P.E.	Executive Sponsor/Facilitation Lead
Melanie Holmer, P.E.	Feasibility-level Technical Lead/Treatment Design Manager
Marc Nakamoto, P.E.	Conceptual-level Technical Lead/Treatment Design Manager
Erin Mackey, Ph.D., P.E.	Environmental Regulations Lead
Katie Ruby, P.E.	Facility Sizing (Flow Capacity and Yield)
Rene Guillen, P.E.	Treatment Design Engineer
Marissa Tsuruda, P.E.	Project Engineer/Satellite Treatment Facility
Joe Burg, P.E.	Economic Evaluation Lead
Adam Zacheis, Ph.D., P.E.	Treatment Design Reviewer/SME
Brett Farver, P.E.	Quality Manager
Jessica Rowe	Deliverable Enhancement
Andrew Buick	Graphic Design

HydroScience Engineers

Curtis Lam, P.E.	Conveyance Infrastructure Design Lead
Navina Venugopal	Project Engineer/Conveyance Design
Alex Park, P.E.	Project Engineer/Hydraulic Modeling/SBWR System Planning
Jonathan Machorro, P.E.	Project Engineer/Hydraulic Modeling/SBWR System Planning

Trussell Technologies

Brian Pecson, Ph.D., P.E.	Potable Reuse Regulatory Compliance Lead
Brie Post, P.E.	Project Engineer/Regulatory Strategy
Anya Kaufman, P.E.	Project Engineer/Regulatory Strategy
Shane Trussell, Ph.D., P.E.	Potable Reuse Technical Reviewer/SME

Katz & Associates

Patricia Tennyson	Public Outreach Strategy

Data Instincts

Mark Milan	Public Outreach Strategy

Geotechnical Consultants/ENGEO

Dustin Agnew, P.E.	Project Engineer/Geotechnical Preliminary Study
Jim Thurber, P.G., C.HG.	Geotechnical Reviewer/SME

Other Contributors

Beth Linskens
Bill Leever
Dennis Mulacek
Desmond Orsinelli
Dolly Chen
Kirk Westphal
Martin Steinpress
Phillippe Daniel
Roger Chu
Rucker Alex

Preface: A Living Document

The Countywide Water Reuse Master Plan (CoRe Plan) is envisioned to be a living document to support future decision-making related to Valley Water's recycled (non-potable reuse) and purified water (potable reuse) programs. As direct potable reuse (DPR) regulations and other influencing factors/conditions (e.g., advances in treatment technologies) continue to evolve and fundamentally change the basis of projects, Valley Water will review and assess such updates relative to the CoRe Plan. As described here, the adaptability incorporated into Valley Water's approach is already being tested and demonstrated.

As Valley Water and its project team were finalizing this CoRe Plan, the State Water Resources Control Board's Division of Drinking Water released an initial draft of DPR regulations on March 22, 2021. With initial draft regulations becoming available after a multi-year effort to complete the CoRe Plan—including development of preliminary treatment trains for DPR portfolios (both raw water augmentation and treated water augmentation) and a regulatory compliance assessment—Valley Water and its project team performed a cursory review of the initial draft regulations and found the anticipated DPR requirements identified in the CoRe Plan adhere closely to those in the draft regulations. Significant elements of the draft regulation include:

- **Technical, managerial, and financial (TMF) capacity**: The draft regulations significantly increase required TMF capacity for DPR projects and clarify the State Board's proposed approach for evaluating TMF capacity of a DPR project's responsible agency (e.g., Valley Water) and respective project partners. The State Board will evaluate TMF capacity across multiple domains, including funding continuity, interagency agreements, staffing, and operator certification. Compliance will require documentation through an extensive suite of reports, programs, and plans beyond those currently required for indirect potable reuse (IPR) projects.
- **Chemical control**: The draft regulations include prescriptive requirements for additional treatment (including design, operation, and performance), expanded monitoring requirements, significant expansion of source control programs, and more stringent control and response limits.
- **Pathogens**: DPR will require significantly higher log reduction value requirements than IPR for all pathogens. The regulations further clarify how those values must be met in terms of the number, types, and diversity of barriers, as well as protocols for validation and continuous verification of the performance of each treatment process.
- **Monitoring and control**: the draft regulations require a higher degree of monitoring (i.e., frequency, locations, and range of contaminants) and more stringent operational control (e.g., automatic diversions and shutdowns) to prevent distribution of water that is not compliant with requirements.

Because many of these requirements were anticipated, the DPR treatment trains included in the CoRe Plan will comply with most of the draft requirements without significant alterations to the process trains. However, the draft regulations have a larger impact on the regulatory compliance assessment given the clarification on several topics previously less defined, such as enhanced source control and TMF capacity requirements. Valley Water will continue to monitor DPR regulatory development and its impact to the CoRe Plan and will provide necessary updates to maintain the efficacy of this planning document for future potable reuse implementation.

Executive Summary

Santa Clara County faces water supply challenges driven by reoccurring droughts, growing population and businesses, California's changing climate, and increasing uncertainty of imported supply reliability. Record-setting temperatures and extreme weather in recent years signal climate change and may foreshadow impacts that are anticipated to increase in frequency and severity.

To adapt to increasing uncertainties and secure a reliable, sustainable water supply for the region, Valley Water set a goal to meet 10% of Santa Clara County's total water demands with recycled and purified water for non-potable and potable reuse by 2025. Reuse improves resilience to future uncertainties, including drought and climate change. The Board also established a long-term goal of producing up to 24,000 acre-feet per year (AFY) of purified water for potable reuse (drinking water) by the year 2040 to bolster supplies. Complementing the potable reuse goal, Valley Water's 2015 Urban Water Management Plan estimates that 33,000 AFY of 2040 demand will be met with recycled water for non-potable reuse (NPR).

Early stakeholder discussions began in 2016 to frame a Countywide water reuse vision. Shortly thereafter in 2018, Valley Water initiated the Countywide Water Reuse Master Plan (CoRe Plan) effort to identify feasible opportunities for expanding reuse as part of the strategy to improve water supply reliability and increase regional self-reliance for Santa Clara County's nearly 2 million residents and growing economy. Developing the plan involved substantial collaboration between Valley Water and its four wastewater Partner Agencies to identify and evaluate reuse opportunities. This CoRe Plan identifies a range of opportunities for expanding reuse through recycled water for NPR and purified water for PR.

What is Water Reuse?

Water reuse is the recycling of wastewater for potable (drinking) and non-potable purposes. Non-potable reuse (NPR) supports landscape irrigation, agricultural, and industrial uses (e.g., cooling systems, fire protection, and toilet flushing). Potable reuse (PR) means recycled water is treated to drinking water standards using advanced purification technology, making it suitable for human consumption as potable water.

As a locally controlled and drought-resistant supply, water reuse allows Valley Water to:

- improve resilience to drought and prepare for climate change impacts,
- reduce the region's dependence on imported supplies (i.e., water originating outside of the region), which accounts for over 50% of Santa Clara County's water use, and
- improve sustainability by reducing energy use and environmental costs related to conveying imported supplies to the region.

The Countywide reuse vision is programmatic and aims to:

1. **Integrate existing recycled water systems and expand NPR**
2. **Develop purified water systems in partnership with recycled water producers/suppliers and other interested parties to enable potable reuse**

The CoRe Plan evaluates a wide range of reuse opportunities and, rather than recommending one defined path forward, provides a framework for collaborative decision-making and flexible, adaptive implementation.

Projects were evaluated based on criteria such as cost, ease of obtaining permits from regulatory agencies, environmental impacts and benefits, flexibility in future expansion, the scale of construction and engineering feasibility, and potential risks to disrupt, delay, or halt projects.

The CoRe Plan explores five different ways of expanding local water supplies through potable and non-potable reuse.

Enhanced Non-potable Reuse (NPR+): blending recycled water with advanced-treated purified water to reduce salinity, allow for more end-uses, and help protect groundwater quality

Groundwater Recharge (GWR): replenishing the groundwater aquifer with purified water

Surface Water Augmentation (SWA): supplementing reservoirs, lakes, or channels with purified water

Raw Water Augmentation (RWA): sending purified water into a pipeline system that delivers untreated water to a drinking water treatment plant

Treated Water Augmentation (TWA): sending purified water directly into the drinking water system

Refer to the glossary at the end of this document for definitions of words and concepts used throughout the CoRe Plan. Within the glossary, an infographic visually depicts the various forms of reuse.

In evaluating and ranking portfolios, Valley Water and its Partner Agencies built upon and integrated existing planning-level studies and reports that identify reuse projects (potable and non-potable) and demonstrate regional benefit. Additionally, Valley Water and its partners identified new projects that show promise in contributing to regional resilience and the 2040 potable reuse goal. Reuse projects were combined into portfolios, primarily distinguished by wastewater source (i.e., Partner Agencies' facilities) and reuse type, then evaluated for feasibility.

As summarized in Table ES-1, project portfolios evaluated in this CoRe Plan include:

Recycled water system expansions

NPR/NPR+	Expanding recycled water distribution systems for NPR countywide (assumed baseline, applied to all portfolios).

Purified water production at one the following locations for potable reuse:

SJ	Constructing a new advanced water purification facility (AWPF) adjacent to the existing Silicon Valley Advanced Water Purification Center in San José for potable reuse through either groundwater recharge, raw water augmentation, or treated water augmentation.
PA + SV	Building an AWPF in either Palo Alto (PA [+SV]) or Sunnyvale (SV [+PA]) to purify supply originating from their respective wastewater treatment facilities and for potable reuse through groundwater recharge.
PA/SV	Building separate AWPFs in both Sunnyvale and Palo Alto for groundwater recharge.
MH	Building a satellite wastewater treatment facility and AWPF in Morgan Hill for groundwater recharge or surface water augmentation.

Table ES-1. Programmatic Approach for Evaluating Reuse Opportunities

	North County Portfolios		South County Options
Countywide Expansion of NPR/NPR+ (Recycled Water Distribution Systems)	San José	One AWPF in San José **1a: SJ GWR** **1b: SJ RWA** **1c: SJ TWA, Milpitas Pipeline** **1d: SJ TWA, new pipeline**	**MH-1: NPR+** **MH-2: GWR** **MH-3: SWA**
	Palo Alto & Sunnyvale	One regional AWPF with combined flows from Palo Alto and Sunnyvale **2a: PA (+SV) GWR** **2b: SV (+PA) GWR**	
		Two separate AWPFs in Palo Alto and Sunnyvale **4: PA/SV GWR**	
Alternative Elements and Future Opportunities **Alternative pipeline alignments, interties, and delivery points. Resized designs. Additional TWA opportunities.**			

In addition to the project portfolios, Valley Water and its Partner Agencies also considered opportunities that may be further explored in the future and alternative elements that could replace some aspects of the portfolios.

Valley Water's Project Team created two tools to compare portfolios: an evaluation tool and a risk tool. The evaluation tool compares portfolios relative to one another based on prioritization criteria identified by Valley Water and its Partner Agencies. The risk tool supports assessment of each portfolio separate from the overall evaluation focusing on aspects that may disrupt, delay, or halt projects and considering the likelihood and consequence of risks. The tool returns a calculated composite risk score for each portfolio; an example is shown in Figure ES-1.

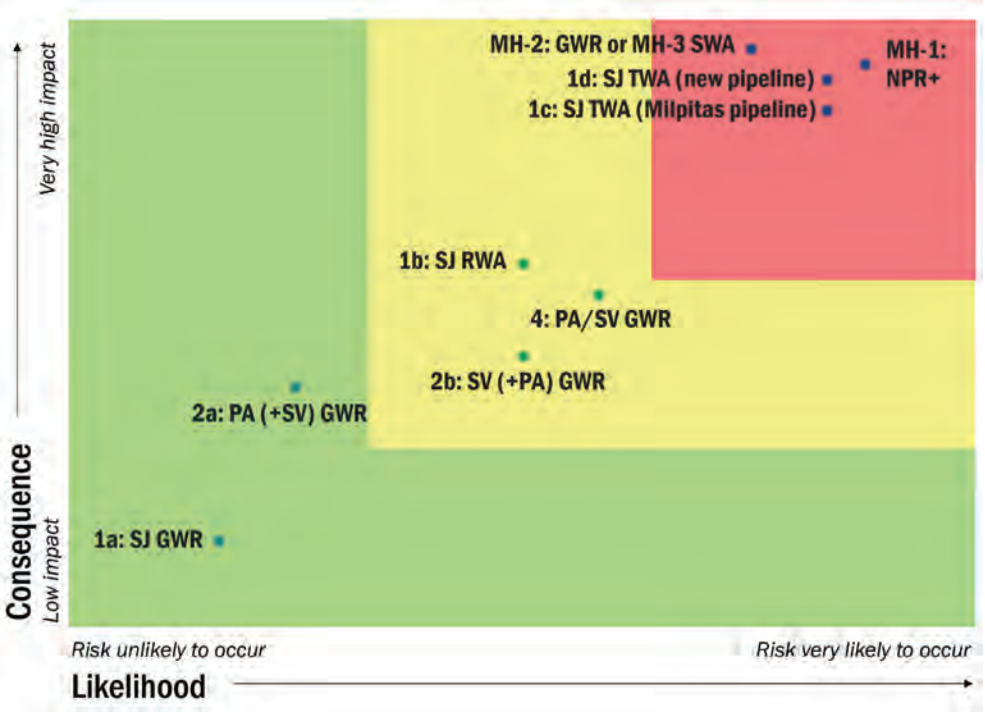


Figure ES-1. Example of risk assessment tool results to compare CoRe portfolios and options

Given the wide range of reuse scenarios considered in this CoRe Plan, implementation planning needs to incorporate flexibility and support future decision-making. While implementation involves many considerations, several that are critically important are addressed in the CoRe Plan including:

- Strategy for regulatory compliance and permitting, including protection of public health and the environment, and strategies for managing residual waste streams generated from AWPFs
- Rate impacts
- Public outreach and engagement
- Partnerships and governance
- Policy issues
- Environmental review and documentation
- Program funding

Valley Water's Project Team also developed cost estimates for the portfolios and for alternative elements. Estimated portfolio costs vary widely based on supply source, AWPF location, production capacity, delivery points, and reuse type, among other factors. To produce around 24,000 AFY of purified water for potable reuse, portfolio capital cost estimates range between $555-$850 million, and unit costs are estimated to range between $2,100-$3,300/AF for 100-year life cycle and $2,500-$4,300/AF for 30-year life cycle.

The cost of implementing reuse opportunities identified in this plan would be met by ratepayers within the relevant groundwater benefit zones. Using preliminary cost estimates documented in previous drafts of this plan, Valley Water staff estimated the anticipated incremental percent increase to the municipal and industrial groundwater production charges for each portfolio and option for a planning period of fiscal years (FY) 2022 to 2030. Incremental rate increases would be in addition to anticipated rate increases unassociated with this plan's portfolios and options.

On average, County residents would pay an additional **$1 to $2 per month*** for this **drought-resistant, local water supply.**

**depending on the portfolio*

Valley Water staff estimated that implementation of a North County portfolio would result in an incremental increase to the Groundwater Benefit Zone W-2 groundwater production charge ranging from 1.6% to 1.9% per year, depending on the portfolio. Rate impacts may be lower with receipt of external funding such as grant awards or low interest loans.

In South County, the implementation of a Morgan Hill option was estimated to incrementally increase the Groundwater Benefit Zone W-5 groundwater production charge by a range of 2.2% (MH-1 [NPR+]) to 4% (MH-3 [SWA]) per year. Based on recently updated cost estimates, rate impacts for MH-2 (GWR) and MH-3 (SWA) are likely to be higher than this estimated increase. Note that Groundwater Benefit Zones W-7 and W-8 in South County do not benefit from the provision of recycled water.

As directed by its Board of Directors, Valley Water is implementing a purified water project that will align near-term source water availability from one of its partners with updated water supply needs. As part of this near-term project, Valley Water is currently investigating a flexible implementation approach that can support potential reuse expansion in the future. The term flexible implementation ("flex implementation") refers to a prudent planning approach for designing and constructing a near-term GWR project (anticipated by 2028) with sufficient flexibility to support potential future increases to treatment facility hydraulic capacity and purified water deliveries, opportunities associated with development of direct potable reuse regulations, and treatment process enhancements as applicable based on reuse type.

Valley Water developed cost estimates for the near-term project under several flex implementation scenarios. As envisioned at this planning level, the near-term project is anticipated to involve construction of a smaller size AWPF (10 mgd production capacity) located in San José or Palo Alto to yield approximately 11,000 AFY of purified water for GWR at the Los Gatos recharge ponds system. To enable future flexibility, Valley Water has assumed the near-term project will include a 36-inch diameter pipeline for purified water conveyance from an AWPF to the recharge system. A 36-inch pipeline would allow Valley Water to potentially expand the 10-mgd treatment facility to produce up to 24 mgd and increase annual deliveries of up to 24,000 AFY for GWR, RWA, and/or TWA, as shown in Figure ES-2. Based on these assumptions of a 10-mgd AWPF designed for recharging around 11,000 AFY and a 36-inch purified water pipeline capable of delivering up to 24,000 AFY, capital cost estimates of the near-term project range between $445-$485 million. This same flex implementation scenario translates to unit costs estimated at $2,600-$3,300/AF (100-year and 30-year life cycles, respectively) for an AWPF located in San José and similarly $2,700-$3,600/AF (100-year and 30-year life cycles, respectively) for an AWPF located in Palo Alto.

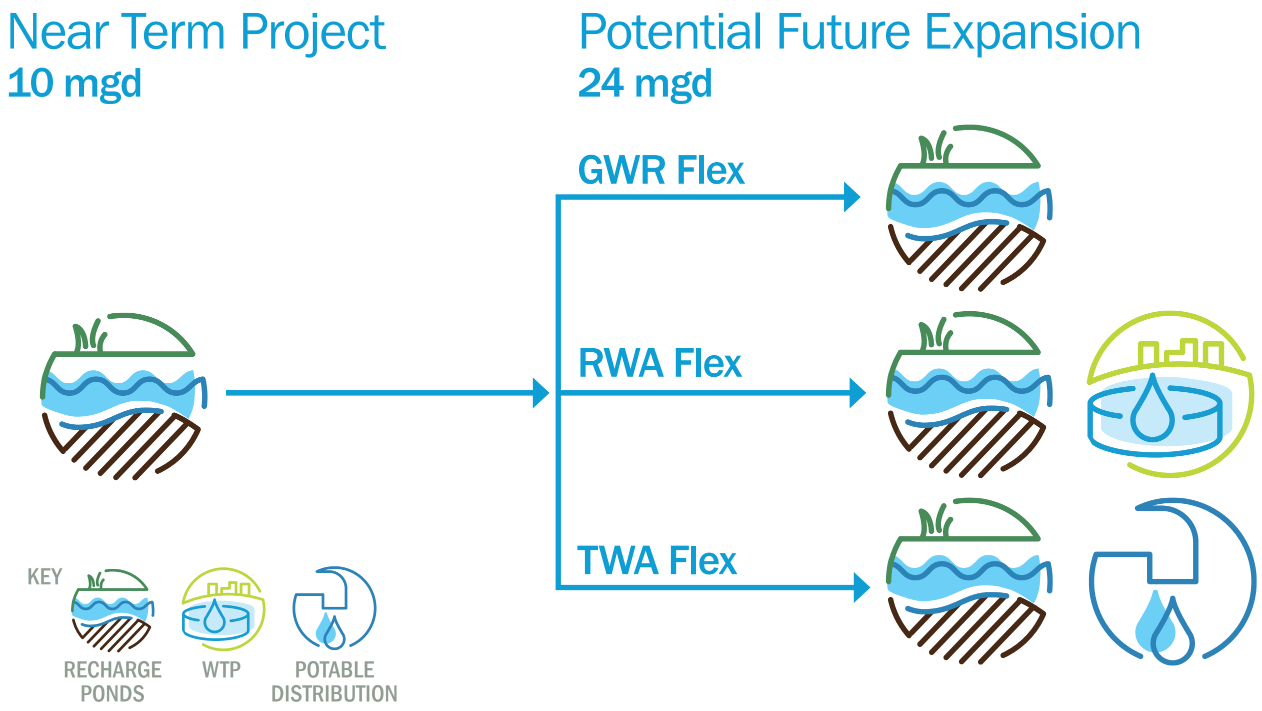


Figure ES-2. Conceptual overview of flexible implementation scenarios

While these planning level potable reuse cost estimates exceed those of existing supplies, Valley Water's current (FY 2020-21) groundwater production charge of $1,374/AF for North County municipal and industrial users is anticipated to surpass $3,000/AF by FY 2029-30 to maintain with necessary investments in water supply infrastructure and increasing operations and maintenance costs. **Santa Clara County is rapidly approaching a tipping point where purified water is cost competitive with other supplies.**

Beyond being cost competitive with other supplies, recycled and purified water offer many additional benefits to Silicon Valley, Santa Clara County communities, and the environment, such as:

Drought-resilient water supply that could reduce dependence on imported water and groundwater.

Saltwater and tidal habitat preservation due to reduced freshwater discharges to the San Francisco Bay in North County and minimized treated wastewater discharge to the Pajaro River in South County.

Ecosystem improvements, including fish habitat, in source watersheds due to reduced imported water reliance.

Removal of emerging contaminants (when using reverse osmosis in advanced treatment) that have become increasingly common to detect, due in large part to refinements in analytical methods and tools.

Improved adaptation to climate change impacts.

The CoRe Plan's Vision was used to chart the path ahead, relying on a robust set of tools and guidance, including:

- Baseline to support ongoing collaboration and reuse partnerships
- Consistent method for evaluating availability of treated wastewater for reuse
- Options for reaching up to 24,000 AFY of Countywide reuse
- Feasibility of potable reuse types (GWR, SWA, RWA, TWA)
- Potential future opportunities (interties, RWA/TWA, onsite reuse)
- Right-sizing infrastructure, including conveyance pipelines
- Decision support tools (risk analysis, alternatives evaluation)

The CoRe Plan is a blueprint for reuse for the next few decades -- a living document -- built to adapt to changing water supply and demand conditions, stakeholder input, ongoing research and evolving regulations.

Section 1:
Introduction

The mission of Santa Clara Valley Water District (Valley Water) is to provide Silicon Valley safe, clean water for a healthy life, environment, and economy. Achieving this mission requires a holistic One Water approach.

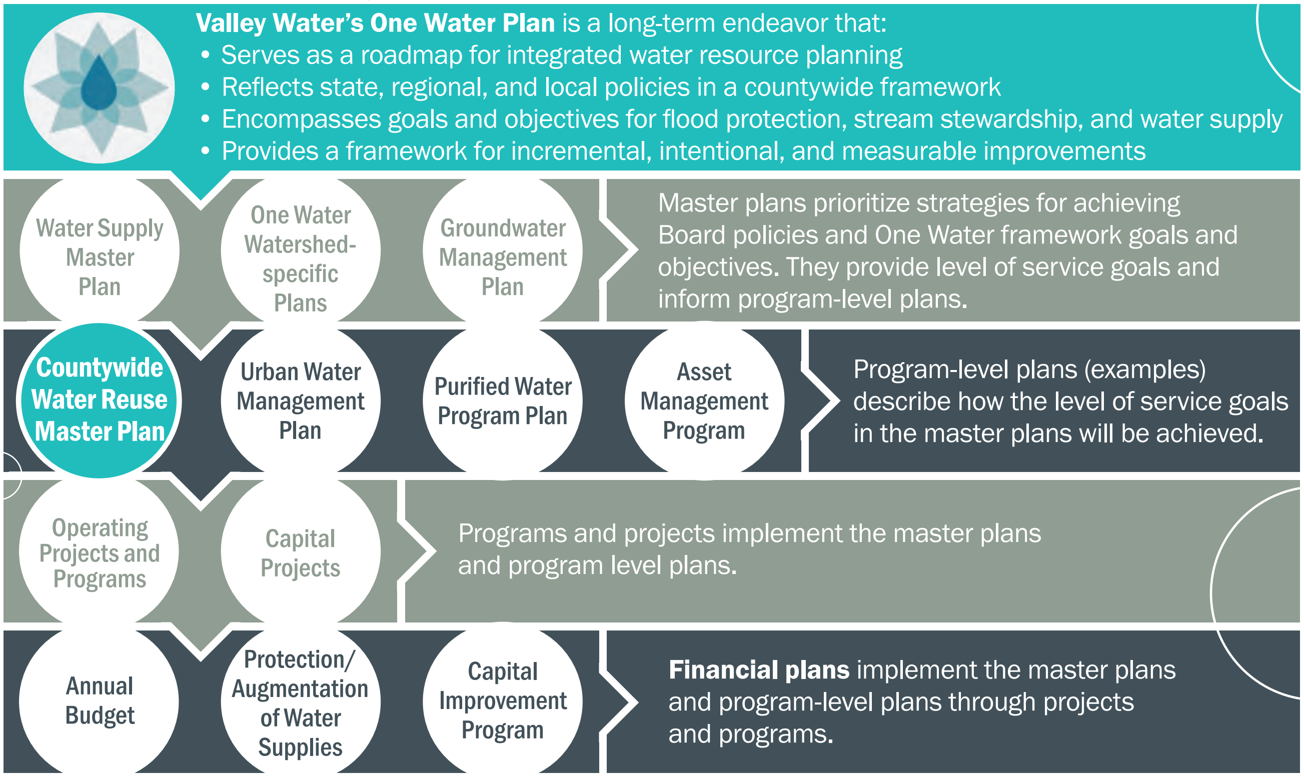
1.1 One Water Approach

In support of its mission, Valley Water developed the One Water Plan as a 50-year roadmap for integrated water resource planning on a watershed scale. The plan brings together state, regional, and local policies into a Santa Clara Countywide framework with goals and objectives for Valley Water's three mission components of flood protection, stream stewardship, and water supply. One Water seeks to provide guidance from an overarching perspective and look for opportunities to further protect and enhance water resources.

Valley Water's holistic, forward-looking approach to water resource management and stewardship includes the One Water approach. This approach leverages partnerships to diversify local water resources, integrate systems to maximize water quantity and quality, and deliver projects that provide multiple benefits. Key objectives include:

- **Reliable water supply**
- **Sustainable groundwater**
- **High-quality water**
- **Flood risk reduction**
- **Expanded floodplains**
- **Supportive stream flows**
- **Resilient habitats**
- **Climate change adaptation**
- **Emergency preparedness**
- **Community engagement**

One Water Countywide Framework



Valley Water's One Water Plan is a long-term endeavor that:
- Serves as a roadmap for integrated water resource planning
- Reflects state, regional, and local policies in a countywide framework
- Encompasses goals and objectives for flood protection, stream stewardship, and water supply
- Provides a framework for incremental, intentional, and measurable improvements

Master plans prioritize strategies for achieving Board policies and One Water framework goals and objectives. They provide level of service goals and inform program-level plans.

Program-level plans (examples) describe how the level of service goals in the master plans will be achieved.

Programs and projects implement the master plans and program level plans.

Financial plans implement the master plans and program-level plans through projects and programs.

Water Supply Master Plan
One Water Watershed-specific Plans
Groundwater Management Plan
Countywide Water Reuse Master Plan
Urban Water Management Plan
Purified Water Program Plan
Asset Management Program
Operating Projects and Programs
Capital Projects
Annual Budget
Protection/ Augmentation of Water Supplies
Capital Improvement Program

Figure 1-1. Valley Water's One Water Plan as a Countywide framework

1.2 Water Supply Planning

In support of its mission, Valley Water has invested in programs and projects over many decades to manage water demands, develop/protect water supplies, maintain existing infrastructure, and construct new facilities. As described in Valley Water's Water Supply Master Plan 2040 (WSMP 2040), these past and ongoing investments enable Valley Water to manage natural variability in demands and supplies to reliably meet Santa Clara County's current water needs in all but critical drought years—and yet, the County's need for water, particularly reliable dry-year supplies, will continue to grow.

Valley Water's Board of Directors established a goal to increase recycled water use, such that reuse supplies meet 10% of total Countywide demands by 2025 and up to 24,000 acre-feet per year (AFY) by 2040. There are many drivers for diversifying and expanding the County's water supply portfolio—including population/ economic growth, increasing climate uncertainty, and other challenges to supply resilience. Recent technological advancements and regulatory developments further support Valley Water's interest in pursuing water reuse as a viable local, drought-resistant potable (drinking water) supply.

The WSMP 2040 evaluates Valley Water's ability to meet Santa Clara County's projected water demands through year 2040 under various conditions and scenarios. Hydrologic conditions considered range from normal water years to six sequential drought years, and scenarios begin with a baseline water supply system and build by layering various potential supply projects to address anticipated shortfalls based on comparing projected future demands and supplies. The baseline water supply system reflects an increase in water retailers' non-potable reuse (NPR) from 18,000 AFY in 2018—an estimated 6% of Countywide demands that year—to about 28,000 AFY in 2025 and 33,000 AFY in 2040.

Based on the WSMP 2040 water demand forecasts, meeting the Board's goal requires designing and constructing new facilities to begin producing at least 9,000 AFY of potable reuse (PR) supply by 2025.

Further, the WSMP 2040's strategy identifies key strategies and projects to improve water supply reliability and drought resilience over the next two decades, including reuse of 57,000 AFY (14% of projected Countywide demands) by 2040—composed of 33,000 AFY for NPR and 24,000 AFY for PR.

To assess water supply reliability and estimate costs and schedule, the WSMP 2040 assumes a placeholder potable reuse project that involves using purified water for groundwater recharge (GWR) at Los Gatos recharge ponds system (LGRP, or LGRS[1]). Valley Water plans to update the modeling assumptions as necessary to reflect consistency with changes to Board-established reliability goals and a confirmed investment strategy. Valley Water's WSMP 2040 acknowledges that the CoRe Plan will identify and evaluate other options for achieving the 2040 reuse target. At the Board's direction, Valley Water will update the WSMP 2040 analysis and project recommendations to align with the CoRe Plan.

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[1] Valley Water's system of recharge ponds located in Los Gatos are referred to as Los Gatos Recharge Ponds (LGRP) system in past documents. In recent documents and going forward, Valley Water is referring to the same facility as Los Gatos recharge system (LGRS).

Achieving Valley Water's goal of meeting at least 10% of the County's 2025 water demands using recycled water requires developing potable reuse and increasing non-potable reuse consistent with Partner Agencies' recycled water system expansion plans.

> "We are the primary water resources agency for all of Silicon Valley, so it's our job to manage and plan for current and future water needs to ensure our region's sustainability," Valley Water Board member Barbara Keegan said. "This includes not just managing the day-to-day water needs for Silicon Valley's residents, businesses, and environment, but also investing in innovative technologies and long-range planning for the region's water needs. By taking a comprehensive, integrated approach to this vital resource, we can protect and preserve it for the benefit of both current and future generations, as well as our valley's environment."
>
> — U.S. Water Alliance One Water Spotlight, March 2016

1.3 CoRe Plan Goals and Objectives

Over decades, Valley Water methodically advanced water reuse in the County by leading planning efforts, developing wholesale recycled water programs, and constructing new infrastructure.

Valley Water initiated the CoRe Plan effort to identify feasible opportunities for expanding reuse as part of the strategy to improve water supply reliability and increase regional self-reliance for Santa Clara County's nearly 2 million residents and growing economy.

Critical to a successful outcome, the CoRe Plan aligns with Valley Water's One Water Plan and WSMP 2040. Developing the plan involved substantial project partner engagement and collaboration to identify and evaluate reuse opportunities.

The Countywide reuse vision evolved over recent years and expanded into a programmatic approach that aims to:

1. Integrate existing recycled water systems and expand NPR
2. Develop purified water systems in partnership with recycled water producers/suppliers and other interested parties to enable potable reuse

The CoRe Plan provides a framework to make collaborative decisions and implement integrated actions to increase water supply reliability throughout the region.

Other CoRe Plan objectives are to:

Determine source water availability and reuse benefits.

Identify sources and flows of recycled water reliably available for reuse, the appropriate split between NPR and PR, and regional (Countywide) and local-level (individual project partner) benefits from NPR and PR.

Evaluate potential regional integration.

Optimize use of supply and infrastructure, build on existing planning studies, and improve system reliability and flexibility.

Consider innovative approaches and provide a basis for collaboration, interagency agreements, and governance related to residuals management, permitting, and land use decisions.

Support regional collaboration and establish a foundation for continued outreach.

Develop and evaluate reuse opportunities—individual projects and collective portfolios that combine projects—and consider implementation pathways.

Increase public support of water reuse through outreach.

To achieve these objectives, Valley Water is collaborating with Partner Agencies (introduced below) that own and operate four separate wastewater treatment plants (WWTP) and recycled water distribution systems in the County.

Figure 1-2 identifies the sewersheds contributing flow to each of the four WWTPs:

- Palo Alto Regional Water Quality Control Plant (RWQCP)
- Sunnyvale Water Pollution Control Plant (WPCP)
- San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF)
- South County Regional Wastewater Authority (SCRWA)

Characteristics of these existing facilities are further described in Section 4.

The four WWTPs produce source water for reuse, and recycled water distribution systems deliver the supply to end users. In some circumstances, a water supplier purchases recycled water from a recycled water producer (i.e., from a WWTP) on a wholesale basis, and the recycled water wholesaler provides the recycled water supply to a retailer that delivers water directly to end users.

The collaboration between Valley Water and the Partner Agencies builds on existing partnerships, plans, and infrastructure; explores a wide range of reuse opportunities that support Valley Water's goals; and yields multiple benefits for the region.

Partner Agencies include:

Recycled Water Producers (WWTPs)

Palo Alto RWQCP

The Palo Alto RWQCP treats wastewater flows from the cities of Palo Alto, Los Altos, Los Altos Hills, and Mountain View; East Palo Alto Sanitary District (EPASD); and Stanford University. The RWQCP produces and distributes tertiary treated recycled water through the Palo Alto/Mountain View Recycled Water System (RWS).

Sunnyvale WPCP

The Sunnyvale WPCP treats wastewater flows from the City of Sunnyvale and portions of Cupertino and San José. A portion of flow at the WPCP receives tertiary treatment that is then distributed as recycled water to retail customers through the Sunnyvale RWS.

SJ/SC RWF

As the largest WWTP in the County, the SJ/SC RWF treats wastewater flows from the cities of San José and Santa Clara (co-owners of the RWF); the cities of Milpitas, Cupertino, Los Gatos, Saratoga, and Monte Sereno; and County Sanitation District Nos. 2-3 (collectively known as Tributary Agencies). In the 1990s, projected population growth and the RWF's effluent discharge limitations set by the National Pollutant Discharge Elimination System (NPDES) permit inspired San José and Valley Water to collaborate in planning development of the South Bay Water Recycling (SBWR) system, a resource recovery system that reuses treated effluent from the RWF for non-potable purposes. Originally, SBWR was constructed to comply with regulations protecting salt marsh habitat by reducing SJ/SC RWF effluent discharges to the San Francisco Bay (SF Bay). In short order, SBWR's water supply benefits became evident.

SCRWA

The cities of Gilroy and Morgan Hill are members of this joint powers authority (JPA) formed to manage treatment of wastewater flows from these two municipalities in the southern portion of Santa Clara County (South County) at the SCRWA WWTP in Gilroy. The South County RWS distributes tertiary-treated recycled water from the WWTP to NPR end users in Gilroy.

Recycled Water Systems

Palo Alto/Mountain View RWS

Palo Alto distributes recycled water from the RWQCP to end users (retail sales) within its service area and provides Mountain View up to 3 million gallons per day (mgd), measured as an instantaneous flow, on a wholesale basis. In 2019, Valley Water, Palo Alto, and Mountain View executed a long-term, 75-year agreement establishing terms for Valley Water to receive 9 mgd of RWQCP effluent for future potable reuse and for subsidized funding of a new 1.125- to 2.25-mgd local advanced water purification facility (AWPF) in Palo Alto. Purified water from the AWPF will blend with tertiary-treated effluent from the RWQCP to reduce total dissolved solids (TDS)—i.e., remove salts—resulting in improved recycled water quality. This blend is referred to as enhanced NPR, or NPR+, and enables broader application of recycled water for non-potable end uses.

Sunnyvale RWS

The Sunnyvale RWS recently expanded with construction of the 2.5-mile Wolfe Road Pipeline—the outcome of a partnership between Valley Water and Sunnyvale that began in 2013 with designing the pipeline to serve customers south of the San Lucar Pump Station and within Cupertino. As part of this institutional arrangement, Valley Water acts as a recycled water wholesaler and provides recycled water to the California Water Service Company (Cal Water), a retailer serving customers on the Wolfe Road Pipeline. The pipeline was designed to allow Cal Water to deliver recycled water from Sunnyvale's RWS to Apple's campus in Cupertino. Valley Water and Sunnyvale are jointly evaluating additional water reuse alternatives, including an AWPF near the Sunnyvale WPCP.

South Bay Water Recycling

SBWR is a recycled water wholesaler and regional permit holder overseeing regulatory compliance for the quality of recycled water produced at the SJ/SC RWF and its use in the cities of San José, Santa Clara, and Milpitas. Operated by the City of San José, SBWR is funded by the SJ/SC RWF capital and operation budget and wholesale recycled water sales to four local water retailers: the cities of San José (via San José Municipal Water), Santa Clara, and Milpitas; and San José Water (an investor-owned utility). Over decades, Valley Water and San José have executed a variety of agreements pertaining to reuse. An agreement established in 2010 set terms for constructing the Silicon Valley Advanced Water Purification Center (SVAWPC), which began operations in 2014. Currently, purified water from the SVAWPC is blended into the SBWR system to improve recycled water quality and reduce TDS. Separately, Valley Water and San José established the Silver Creek Pipeline Agreement that allows Valley Water to wholesale for 5 mgd of SBWR recycled water within a dedicated service area.

South County RWS

SCRWA's recycled water system began operating in 1977 during a historic drought. Operations became intermittent due to a lack of consistent demand for NPR and variabilities in recycled water quality until the 1990s. In 1999, Valley Water and SCRWA executed agreements that established cost-sharing terms and partnering to develop a reuse master plan and capital improvement program, and to define their respective roles pertaining to South County reuse—namely SCRWA as the NPR producer, Valley Water as the wholesaler, and the two municipalities as retailers (though Morgan Hill does not currently have a recycled water distribution system). Terms of one executed agreement establish that SCRWA may sell flows of recycled water that exceed the annual delivery quantity (a mutually agreed-upon flow established each year) to other wholesalers/end users, and Valley Water may sell recycled water to be used by end users outside of the South County RWS service area (with SCRWA's approval).

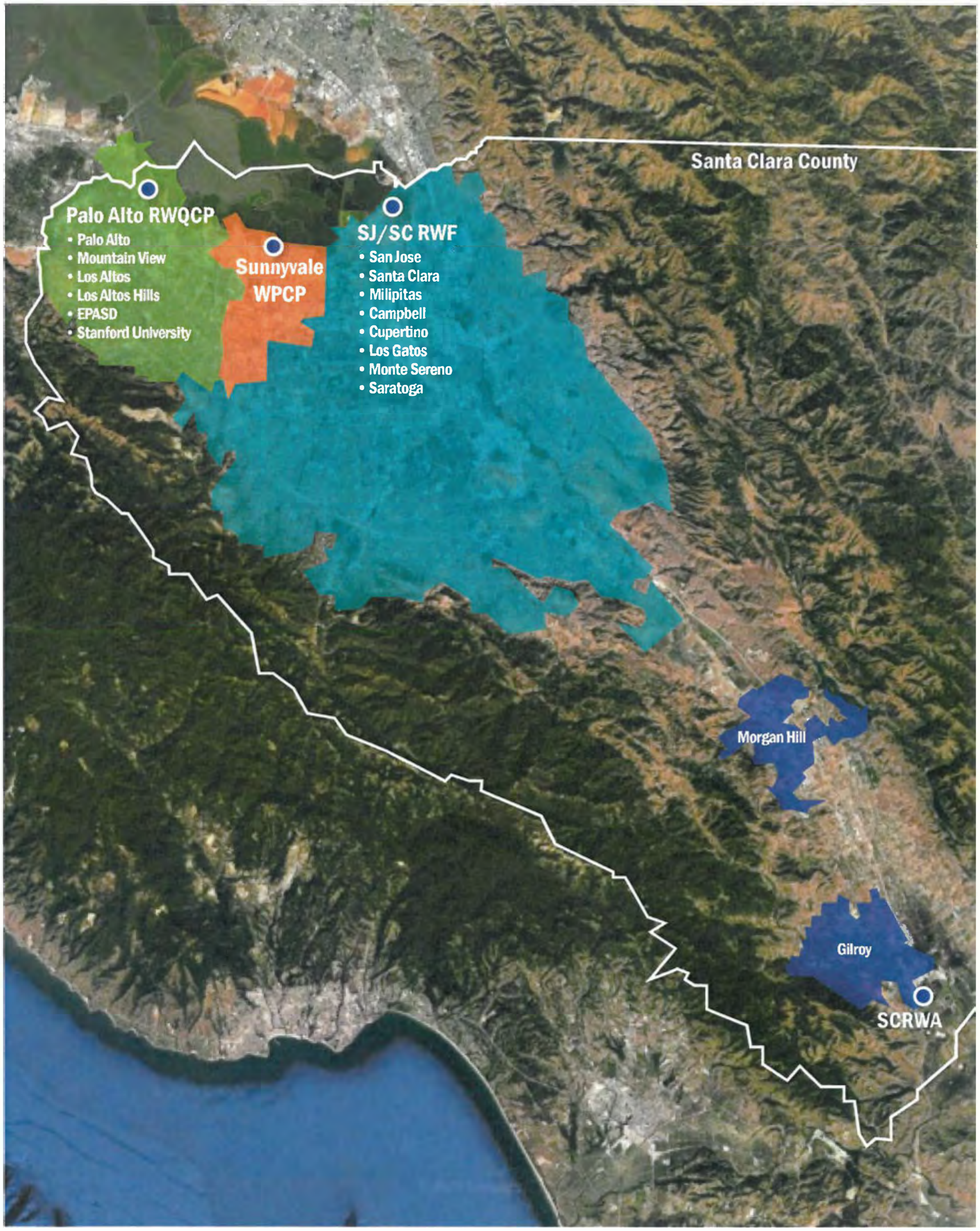

Figure 1-2. Partner Agencies' sewersheds contributing flow to each of the four WWTPs

Section 2:
Partnerships and Engagement

Creating a blueprint for a new regional reuse program requires early, frequent, and meaningful collaboration among Valley Water, Partner Agencies, and stakeholders.

To develop and sustain a common vision for the region, robust engagement across various interest groups and levels is imperative. A Countywide approach can benefit the collective region by enhancing water supply reliability, increasing use of existing infrastructure investments, facilitating water transfers during critical shortages, and improving resilience to droughts and climate change.

The engagement approach for developing the CoRe Plan enabled opportunities for a myriad of agencies and subject matter experts to offer input to the plan's development, garner good will, and generate support (as shown on Figure 2-1).

Staff from Valley Water's Recycled and Purified Water Unit led development of this plan as a Countywide Reuse Project Team, in coordination with:

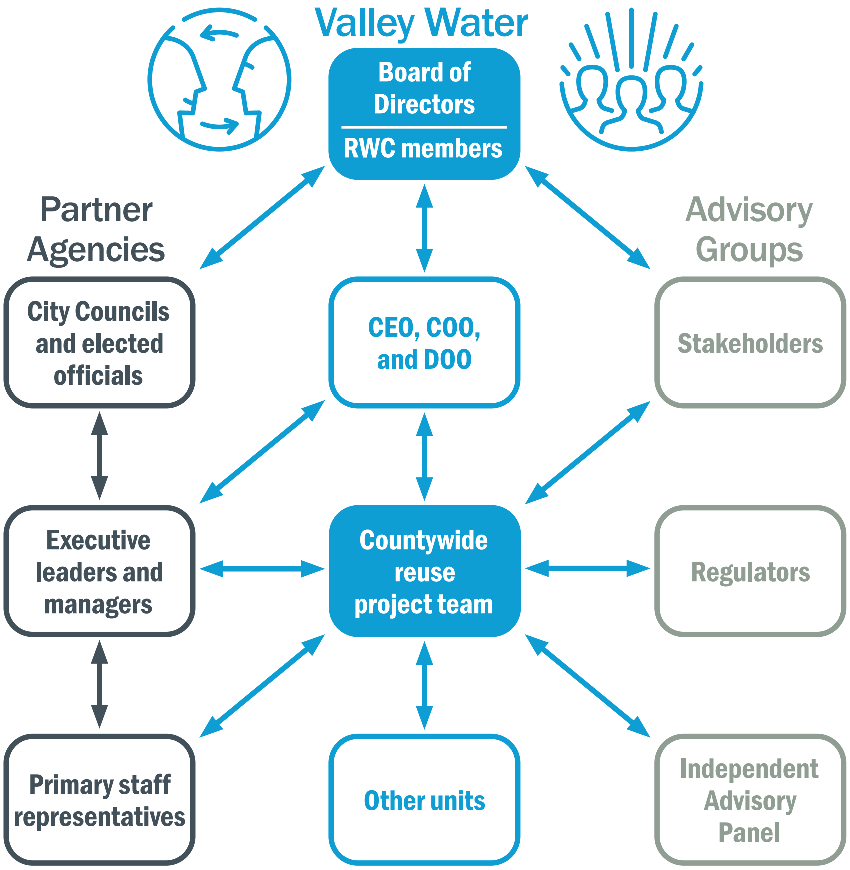
Valley Water
Board of Directors
RWC members
Partner Agencies
Advisory Groups
City Councils and elected officials
CEO, COO, and DOO
Stakeholders
Executive leaders and managers
Countywide reuse project team
Regulators
Primary staff representatives
Other units
Independent Advisory Panel

Figure 2-1. Blueprint for robust engagement and collaboration at multiple levels across various groups to inform the CoRe Plan development

Note: CEO = Chief Executive Officer; COO = Chief Operating Officer; DOO = Deputy Operating Officer

VALLEY WATER'S POLICYMAKERS

Valley Water's Board of Directors, composed of seven elected representatives responsible for adopting policies to govern processes and the Board's Recycled Water Committee (RWC)

PARTNER AGENCIES

Partners' staff representing various levels of authority and roles, complementary to those of Valley Water, such as: policymakers (joint committees composed of elected officials and policymakers from Valley Water's RWC and Partner Agencies' city councils or policy advisory committees), executive managers, and staff representatives

ADVISORY GROUPS

Three distinct groups, defined as follows:

- **Stakeholders** invited to participate as task force members, including representative interests/organizations related to business/ economy, chambers of commerce, planning, public policy, environmental advocacy, environmental justice, medical community, diversity, stormwater, groundwater, other water and recycled water suppliers/agencies
- **Regulators** including the State Water Resources Control Board's Division of Drinking Water (DDW) and Regional Water Quality Control Boards, Region 2 (San Francisco Bay) and Region 3 (Central Coast)
- **Independent Advisory Panel (IAP)**, a third-party body composed of leading potable reuse researchers and subject matter experts

While each aspect of the engagement strategy is important, collaboration with Partner Agencies is uniquely critical to the CoRe Plan's success.

Partnerships between Valley Water and recycled water producers are key to unlocking a path forward for regional reuse. Separately, recycled water producers and Valley Water lack required resources to achieve regional supply reliability through reuse, but together, partnerships create win-win solutions whereby smaller retailers achieve reuse goals through Valley Water's financial support while Valley Water secures source water needed to achieve Countywide reuse goals and increased local self-reliance. Long-term agreements between project partners are a critical premise for securing reliably available source water for reuse; the absence of which would call into question the realistic feasibility of implementing a Countywide program. Valley Water and Partner Agencies have invested substantial time and effort in collaborating to develop the CoRe Plan. Each Partner Agency provided valuable contributions and unique insight and perspective through group forums, one-on-one meetings, and written feedback that have been considered and, to the extent possible and practicable, addressed in the plan.

Engaging partners early in the process and at key decision points helps build support and pave the way forward.

This engagement approach sets the tone for continued collaboration as implementation of regional reuse strategies continues. Moving forward, Valley Water's collaboration strategy will continue to emphasize meaningful engagement across various groups and decision-making levels, including the public.

Valley Water will continue efforts to establish partnerships and create new institutional structures to support a common vision for the region. Throughout this planning process and in the future, Valley Water is committed to proactively addressing governance issues to help forge consensus among diverse stakeholders, memorialize commitments, and articulate the vision in actionable planning documents, such as this one.

The mechanism for input varies depending on influencing factors—such as group composition, project milestones/status, schedule sequencing/interdependencies—and takes the form of group meetings, strategic workshops, one-on-one meetings, and written comments. Facilitated meetings and workshops start with empowering stakeholders with critical information to establish a clear, level baseline of working knowledge and support productive group dialogue and decision-making.

2.1 Reuse Roles and Responsibilities within Santa Clara County

A seven-member Board of Directors is elected in overlapping four-year terms to represent geographical districts in the County and govern Valley Water. At the Board's direction, Valley Water's CEO and other executive managers oversee operations and performance of staff.

Valley Water's roles and responsibilities are shaped primarily by California state law (i.e., the District Act) along with various Board-established policies and institutional agreements with other parties. Additionally, Valley Water is considered an independent "special district", informally defined as a separate local government that delivers public services to a particular area.[2] Table 2-1 shows Valley Water's roles and responsibilities related to water reuse.

Table 2-1. Valley Water's Responsibilities as a Leader and Partner Advancing Countywide Reuse

Role	Valley Water's Responsibility
Countywide and regional planning for sustainable, resilient water supplies	Develop strategies to secure and optimize the use of existing water supplies and infrastructure and to expand water reuse and long-term water conservation savings. Lead Countywide water supply planning and coordinate with water retailers, reuse partners, and external interest groups. Participate in the Bay Area Regional Reliability (BARR) partnership with other water suppliers to improve integrated regional water management, drought mitigation, and supply resilience.
Water retailer assistance	Coordinate and collaborate regularly with the 13 local water retailers (including 7 with treated water contracts) in the County to share information, offer technical support, and help develop regional alliances.
Reuse planning, funding, and facilities	Lead collaborative efforts and partnerships to plan reuse projects; cost-share to fund reuse projects; and construct, operate, and maintain reuse facilities.
Reverse osmosis concentrate management	Facilitate collaborative workshops with stakeholders to develop solutions for managing reverse osmosis concentrate (ROC)—a concentrated waste stream resulting from filtration using reverse osmosis—in addition to conducting pilot-scale testing of treatment alternatives.
Water conservation	Lead Countywide water conservation efforts with innovative, comprehensive programs.
Local surface water management	Operate and maintain 20 appropriative water rights licenses and 1 water rights permit[3] filed with the State Water Resources Control Board to capture local runoff and store local and imported supplies totaling more than 227,300 AFY.
Groundwater management	Lead Groundwater Sustainability Agency (under California's Sustainable Groundwater Management Act) to manage the County's groundwater through comprehensive programs and investments, including in-lieu recharge and storage of surface water in groundwater basins for use in dry years.

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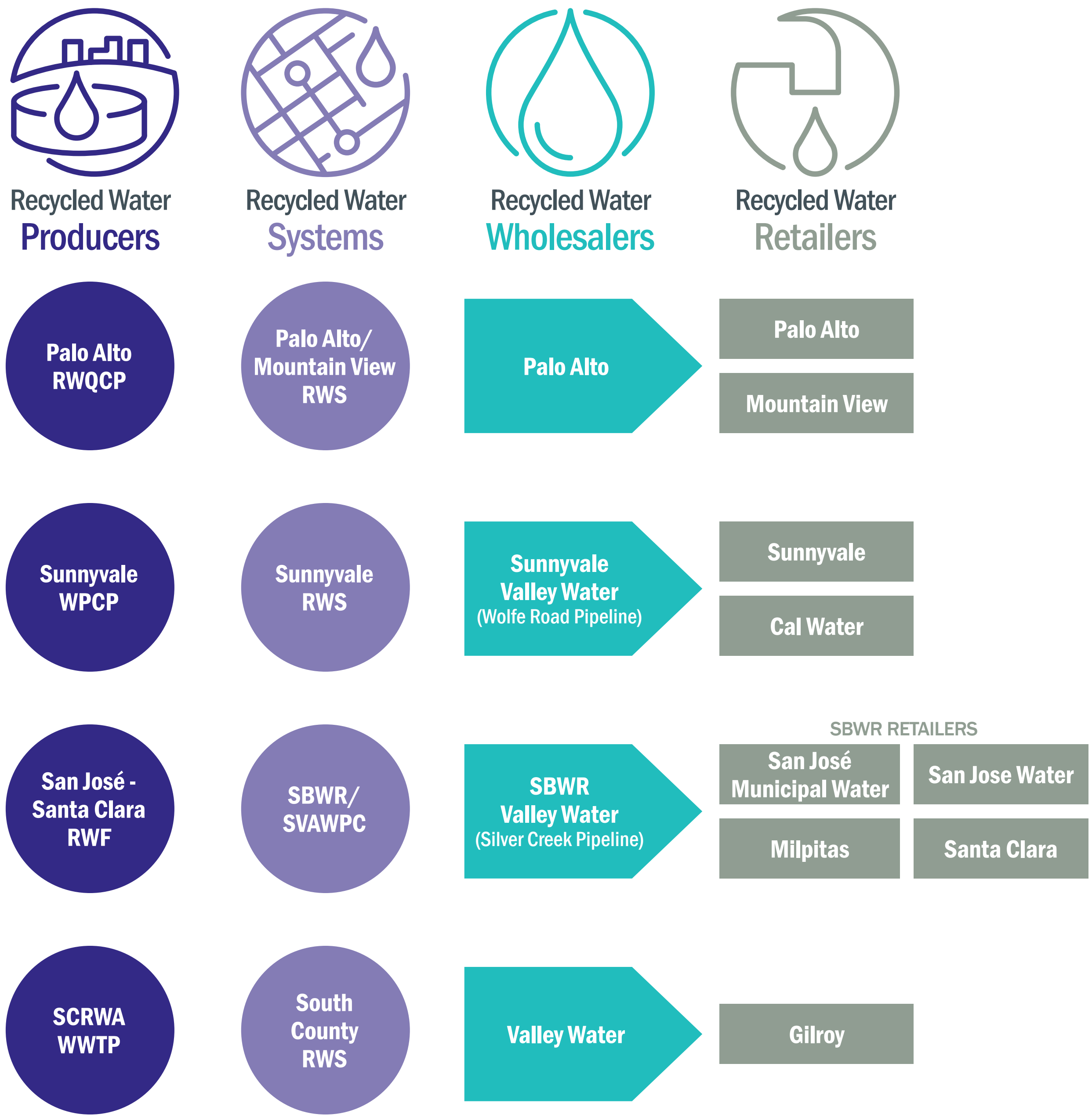
[2] Per Government Code §16271 [d], a special district is an agency of the state for the local performance of governmental or proprietary functions within a limited boundary. Separate generic statutes apply to special districts that are municipal water suppliers. While the respective Local Agency Formation Commission (LAFCO) administers the formation process, establishing a special district requires voter approval by individuals residing within the geographic area who would be influenced by its proposed fees/services. Special district formation typically requires a majority vote, though two-thirds voter-approval is needed if a proposal involves new special taxes. Special districts are governed by elected boards and may only provide public services allowed by state law.

[3] Under California law, appropriative water rights allow diversion of surface water at a specific point and for beneficial use in a different location. In contrast, riparian rights are based on ownership of property adjacent to a waterbody.

As described in Section 1, project partners for this plan include Valley Water and the Partner Agencies that operate the four WWTPs in the County and currently fulfill roles related to treatment and delivery of recycled water through existing distribution systems. Figure 2-2 depicts project partners' roles in the treatment, delivery, and sale of recycled water. Wholesalers sell water to retailers, while retailers sell water directly to customers and provide customer service. A single entity may serve all roles as a recycled water producer, owner/operator of a recycled water system, wholesaler, and retailer—such as Palo Alto and Sunnyvale.

Current Reuse Roles

Treated WWTP effluent supplies the Partner Agencies' recycled water systems



Recycled Water **Producers**	Recycled Water **Systems**	Recycled Water **Wholesalers**	Recycled Water **Retailers**
Palo Alto RWQCP	**Palo Alto/ Mountain View RWS**	**Palo Alto**	**Palo Alto** **Mountain View**
Sunnyvale WPCP	**Sunnyvale RWS**	**Sunnyvale** **Valley Water** (Wolfe Road Pipeline)	**Sunnyvale** **Cal Water**
San José - Santa Clara RWF	**SBWR/ SVAWPC**	**SBWR** **Valley Water** (Silver Creek Pipeline)	SBWR RETAILERS **San José Municipal Water** **San Jose Water** **Milpitas** **Santa Clara**
SCRWA WWTP	**South County RWS**	**Valley Water**	**Gilroy**

Figure 2-2. Current roles and interagency relationships supporting reuse throughout the County

2.2 Relevant Institutional Arrangements

Current agreements between Valley Water and the Partner Agencies relevant to the CoRe Plan are summarized below. A comprehensive list of past and current agreements is included in Attachment B of ***Appendix D*** (Project Definition, Roles, and Responsibilities). Additional arrangements will be necessary to implement various project elements, as discussed in Section 8.3.

Palo Alto / Mountain View; 2019 Cost Sharing and Supply Agreement

[Expires December 10, 2095]

In December 2019, Valley Water executed an agreement with the cities of Palo Alto and Mountain View that defined cost-sharing and supply commitments related to reuse. The agreement extends until December 10, 2095. Key provisions include:

- Cost-sharing for constructing a $20 million local AWPF in Palo Alto for enhanced NPR (NPR+) or other alternatives that benefit RWQCP partners.
- Commitment of 9 mgd of effluent (minimum annual average flow) from Palo Alto to Valley Water at a cost of ~$100/AF for treatment at a regional AWPF.

Sunnyvale; Wolfe Road Pipeline

[Expires 2025; renews every 5 years]

In 2015, Valley Water, Sunnyvale, Apple, and Cal Water agreed to cost-share construction of the Wolfe Road Pipeline. Key provisions of the Recycled Water Supply and Distribution Agreement between Sunnyvale (producer) and Valley Water (wholesaler) include:

- Valley Water owns, but Sunnyvale operates and maintains, the pipeline. Recycled water conveyed through the Wolfe Road Pipeline is owned by Valley Water and may be resold to Valley Water's other customers, regardless of their location.
- For recycled water from Sunnyvale flowing through Wolfe Road Pipeline, a commitment of at least 500 AFY for Valley Water's distribution to users outside the city and an entitlement of up to 595 AFY (and option to purchase more, subject to Valley Water's approval) for Sunnyvale's end users within the city.

City of San José; SBWR Expansion and Silver Creek Pipeline

[Expires January 22, 2027]

In 2002, Valley Water and San José entered into a 25-year agreement to develop a framework for long-term ownership, operation, maintenance, and future expansion of SBWR, and to share costs for the Silver Creek Pipeline. Per the agreement, the City owns the pipeline and acts as wholesaler for recycled water to be delivered to the Metcalf Energy Center and other end users within San José Municipal Water's service area. Valley Water has rights to 5 mgd of recycled water from the Silver Creek Pipeline with the potential for more depending on availability.

City of San José; SVAWPC Agreements

[Expire June 30, 2050]

Under the Ground Lease and Property Use Agreement, Valley Water must operate and maintain the SVAWPC, accepting up to 12 mgd of secondary effluent from the SJ/SC RWF to provide up to 8 mgd of purified water for NPR+ (targeting TDS levels of about 500 to 550 milligrams per liter (mg/L), which corresponds with the TDS limit for potable water and supports protection of groundwater quality).

The Operations and Maintenance Agreement for SVAWPC requires the SJ/SC RWF to accept 1.5 mgd of waste stream discharge and 2 mgd of ROC.

SCRWA; Producer-Wholesaler Agreement

[Expires December 31, 2026]

In October 1999, Valley Water and SCRWA executed a series of three 20-year Producer-Wholesaler agreements (updated in 2006) that established SCRWA as the producer, Valley Water as wholesaler, and the City of Gilroy as retailer of recycled water. As part of the agreements, SCRWA may sell recycled water that exceeds the annual delivery quantity (a mutually agreed-upon flow established each year) to other wholesalers or end users, and Valley Water may sell recycled water to end users outside of the Producer's service area (with approval by SCRWA).

In addition to Valley Water agreements, Partner Agencies have other contractual arrangements that establish financial/supply obligations and other requirements. In some cases, these obligations restrict flow for certain uses, and new or amended agreements may be required to make flow available for projects considered within this CoRe Plan. For example, under a current agreement that expires in 2060, Palo Alto is required to make recycled water available to Mountain View on a demand basis with a peak flow rate of up to 3 mgd. Both Palo Alto and Mountain View have the right to approve or reject proposals to extend their respective distribution systems and transfer recycled water through their own infrastructure and out of their service areas, provided they do not exceed their recycled water allocations.

Terminology: Units for measuring flow and yield

mgd = million gallons per day: Used in context of defining capacity (maximum possible, or peak, flow) for treatment and conveyance facilities and/or characterizing average water/ wastewater use over any timescale.

AFY = acre-feet per year: Used when referring to annual supply or demand over a longer timescale (one or more years). Overall project yield uses AFY.

Appendix A-2 (Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield) provides additional details.

Section 3:
Regulatory Framework

The CoRe Plan considers a wide range of reuse scenarios, giving way to a spectrum of applicable regulatory and permitting requirements. In general, regulations for water reuse fall into two categories: public health protection (consumption) and environmental protection (discharges).

Since the California Legislature began regulating water reuse in 1969, the state has enacted over 100 relevant statutes. Regulations and permit requirements are integral to shaping more detailed aspects of reuse projects. The intended use(s) of reuse supply and potential impacts to human health and the environment are at the core of these regulations and requirements, establishing clear, enforceable boundaries in the public interest. While end uses for reuse supply typically drive the selection of treatment processes, other factors are considered, such as programs requiring and overseeing source water quality control, monitoring, and response. In addition, the technical, managerial, and financial (TMF) capacities of agencies responsible for treatment, conveyance, storage, and distribution of reuse supplies is a critical consideration.

While this section merely introduces reuse regulations, ***Appendix B-2*** (Regulatory Framework Technical Memorandum [TM]) addresses the topic in substantially more detail.

3.1 Regulators and Respective Purviews

Upon adopting the Porter-Cologne Act in 1969, the California Legislature established a comprehensive program to protect water quality and beneficial uses of water, along with an agency with relevant statutory authority—the State Water Resources Control Board (State Board). The State Board is responsible for setting statewide water quality policy, establishing and enforcing water regulations, and overseeing water reclamation requirements (WRR) and waste discharge requirements (WDR).

The Act also established nine Regional Water Quality Control Boards (**Regional Boards**) under the State Board's overall authority with roles defined by their respective individual geographic boundaries. Regional Boards hold the responsibility of administering permit systems to enforce compliance with water quality criteria for recycled water and discharge regulations.

Regional Board

Enforcement of **Environmental Discharge Criteria:** Water quality requirements to protect surface water and groundwater quality for all designated beneficial uses

The State Board's **Division of Drinking Water** (DDW, formerly California Department of Public Health) has statutory authority over two aspects of water reuse:

1. Regulation of public water systems in accordance with the California Safe Drinking Water Act (Health and Safety Code Section 116270 et seq.); and
2. Development and adoption of water recycling criteria as required by Section 13521 of the California Water Code.

DDW

Enforcement of **Public Health Protection Criteria:** Requirements for treatment, monitoring, and effluent water quality for the end use (e.g., landscape irrigation and GWR)

Primary responsibilities of the Regional Boards and DDW are further described as follows.

Regional Water Quality Control Boards

Regional Boards implement water quality planning and regulatory decisions for their specific regions, such as issuing waste discharge requirements (i.e., discharge permits), administering National Pollutant Discharge Elimination System (NPDES) permits for receiving surface water bodies, and enforcing Salt and Nutrient Management Plan (SNMP) requirements for groundwater protection.

The SF Bay Regional Board (Region 2) regulates discharge facilities in the northern part of Santa Clara County (North County), while the Central Coast Regional Board (Region 3) regulates SCRWA's discharges in the South County (see Glossary [figure labeled Visual Glossary-3] for locations).

NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent.

Regional Boards are responsible for specific regulatory areas affecting water reuse:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing water reclamation (reuse) requirements to producers and users
- Defining beneficial uses of surface water bodies and groundwater basins through water quality control plans
- Regulating treatment facility operators
- Determining water rights regarding reuse

In context of the CoRe Plan, three contemplated activities trigger the need to seek new or modified NPDES permits or WDRs/WRRs[4] through Regional Boards, including discharging:

1. Purified water to spreading basins for GWR
2. Purified water to Anderson Reservoir for surface water augmentation (SWA)
3. ROC discharge through surface water outfalls or to local evaporation ponds

Most PR applications in California use full advanced treatment (FAT), which involves reverse osmosis and produces a ROC waste stream that may contain concentrated levels of TDS, nutrients, metals, and toxicity. ROC discharge to a surface water body requires NPDES compliance accomplished through either modifying an existing NPDES permit or obtaining a new one. Modifying an existing permit warrants careful review of potential impacts that may compromise compliance with effluent discharge water quality requirements and trigger further waste stream treatment and/or permit modifications. Other ROC management strategies, such as deep well injection or evaporation ponds, require a WDR permit. Like discharges to surface water bodies, these ROC streams also need to comply with the applicable Basin Plan requirements.

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[4] WDR may be applicable to ROC management involving deep well injection or evaporation ponds, while WRR and WDR both may be applicable to product water released to spreading basins for GWR.

SNMPs establish pertinent water quality objectives (WQOs) to protect groundwater quality from potential degradation. Although NPR for irrigation may increase salts and other contaminants in groundwater, NPR+ water supplied by SBWR helps protect groundwater quality by supplementing recycled water with purified water that contains less salts and other contaminants and results in a target TDS concentration between 500 to 550 mg/L. Palo Alto is constructing a new local AWPF to create NPR+ supply, and Sunnyvale may opt for NPR+ supply in the future, further decreasing risk of degraded groundwater quality from use of recycled water for irrigation.

Division of Drinking Water

DDW develops and enforces public health protection requirements contained in the California Code of Regulations (CCR) Title 22 Uniform Water Recycling Criteria. DDW regulations around potable reuse depend on the type of reuse. For NPR, DDW set increasingly stringent water quality requirements proportionally with the potential for public exposure. For GWR, water quality requirements are more stringent for subsurface injection than for surface spreading. DDW has set a high bar for SWA water quality requirements to protect public health. DDW is currently working on DPR regulations for both RWA and TWA; these regulations are anticipated for release as early as 2023.

DDW specifies public health requirements for water reuse, such as:

- **Pathogen control**
- **Chemical control**
- **Source control**
- **Monitoring/control**
- **Retention/response time**
- **TMF capacity**

3.2 Independent Advisory Panel

The Independent Advisory Panel (IAP) is a third-party body composed of six leading potable reuse researchers and subject matter experts that were invited to review and provide feedback on proposed CoRe Plan projects, portfolios, and options related to technical feasibility and regulatory compliance. IAP members include:

- James Crook, Ph.D., P.E., BCEE
- Katherine Cushing, Ph.D.
- Jean Moran, Ph.D.
- Adam Olivieri, Dr.P.H., P.E.
- Mehul Patel, P.E.
- Shane Snyder, Ph.D.

The IAP met in July 2020 to share input on the Countywide reuse portfolios, as reflected in the Draft CoRe Plan completed earlier that month. Panel members noted that GWR has the highest likelihood of meeting the current target completion date of 2028 given the maturity of the associated regulations. However, the IAP cautioned that even GWR via surface spreading can take substantial time to implement and requires strong partnerships with participating agencies. The IAP also provided valuable input on CoRe Plan details such as proposed treatment trains, source control planning, and monitoring considerations, which are summarized in ***Appendix B-1***.

3.3 Non-Potable Reuse (Recycled Water)

Water recycling is a form of resource recovery and can be referred to as NPR when serving non-potable end uses, such as irrigation, landscaping, commercial dual-plumbed facilities (i.e., toilet and urinal flushing), or industrial processes (e.g., mechanical cooling systems). In centralized systems, recycled water is typically treated at a WWTP, distributed through a dedicated purple-pipe system (separate from the potable distribution system), and sold to recycled water users.

California regulates recycled water according to CCR Title 22 including treatment, discharge, end use, and cross-connection control. Title 22 addresses water-related issues in the context of environmental health and defines four categories of recycled water based on level of treatment and resulting water quality, as described in greater detail in ***Appendix B-2***.

Each of the Partner Agencies produces and distributes recycled water that is consistent with Title 22's highest level of treatment for NPR—disinfected tertiary. Further, some Partner Agencies distribute (or will soon distribute) a blend of recycled water and purified water that surpasses the requirements for disinfected tertiary, referred to as NPR+ (meaning, enhanced NPR). Blending purified water with recycled water helps to improve water quality by reducing salinity (TDS) and constituents left untreated through tertiary treatment, such as constituents of emerging concern (CECs) including PFAS. State regulations do not require the monitoring of CECs in recycled water supply serving non-potable applications. Regardless, Valley Water will continue to track potential developments in terms of relevant research and regulations and assess potential impacts of CECs in recycled water on groundwater quality.

3.4 Potable Reuse

California's regulations acknowledge five specific types of PR (Figure 3-1), each subject to specific permitting requirements. In many cases, these differences are linked to the existence and size of an environmental buffer. As the buffer diminishes in size—or is eliminated in many direct potable reuse (DPR) scenarios—regulatory requirements for other project components increase.

Environmental buffers provide a myriad of benefits—less stringent wastewater and AWPF treatment requirements (due to the attenuation of constituents in the environment), dilution to minimize potential chemical contaminant peaks, and/or decreased monitoring requirements due to increased response time.

Compared to IPR, DPR applications (as raw water augmentation [RWA] and treated water augmentation [TWA]) may involve elimination or significant reduction of the environmental buffer. Consequently, enhanced requirements are anticipated for pathogen control, chemical attenuation, real-time monitoring, engineered storage, and blending. Though regulations for RWA and TWA are not yet developed, potential future requirements can be inferred from DDW's recent publications and presentations, the California DPR Expert Panel[5], and the Project Team's engagement in DPR research and permitting. An evaluation of regulatory compliance strategy for the portfolios' PR elements is summarized in Section 8 and presented in more detail in ***Appendix B-1***.

> **GWR via surface spreading or direct injection is the least-direct form of PR. In 2014, which more than 50 years since California's first successful indirect potable reuse (IPR) project began in 1962, the State finalized GWR regulations.**
>
> **The extended period between initial GWR implementation and final regulations provided regulators an opportunity to learn how to protect public health while fostering the growth of this alternative water supply. Recently finalized in 2018, SWA regulations developed more quickly, yet still benefited from the lessons learned and process of adopting GWR regulations.**

Refer to the glossary at the end of this document for definitions of words and concepts used throughout the CoRe Plan. Within the glossary, an infographic visually depicts the various forms of reuse, including NPR and PR.

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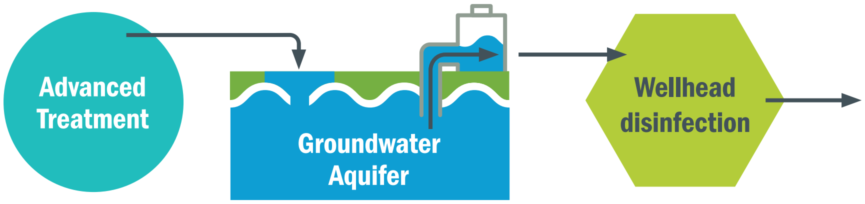
[5] DPR Expert Panel members include: Michael Anderson, Ph.D.; Richard Bull, Ph.D.; James Crook, Ph.D., P.E. (Panel Co-Chair); Dr.-Ing. Jörg Drewes; Charles Haas, Ph.D.; Walter Jakubowski; Perry McCarty, Sc.D.; Kara Nelson, Ph.D.; Adam Olivieri, Dr.P.H., P.E. (Panel Co-Chair); Joan Rose, Ph.D.; David Sedlak, Ph.D.; and Timothy Wade, Ph.D.

Forms of Potable Reuse

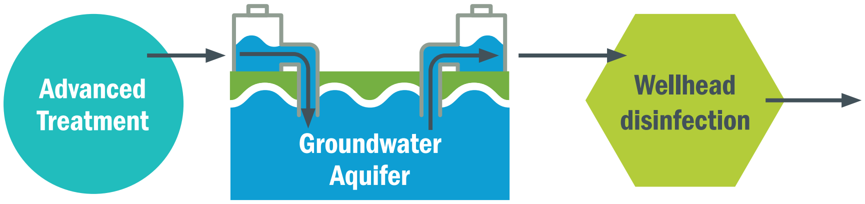
Groundwater recharge: Surface Spreading*

IPR with a substantial environmental buffer: Surface-spreading of full-advanced-treated purified water in percolation ponds for groundwater recharge



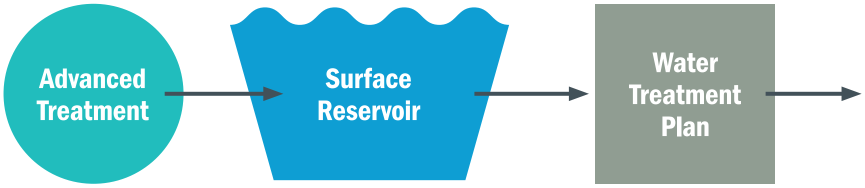
Groundwater recharge: Subsurface Injection

IPR via subsurface injection of full-advanced-treated purified water directly into the groundwater aquifer



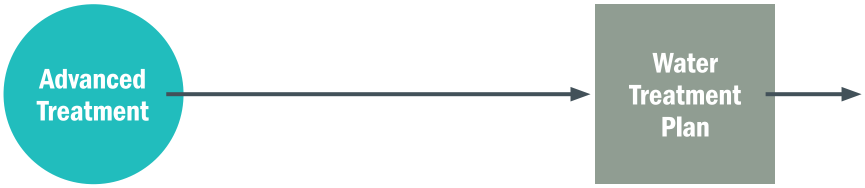
Surface Water Augmentation

IPR involving addition of full-advanced-treated purified water to a surface water reservoir



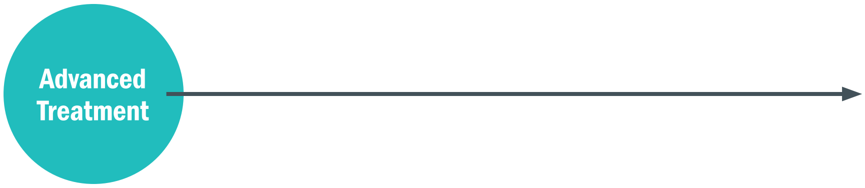
Raw Water Augmentation

DPR via blending full-advanced-treated purified water with raw, untreated surface water upstream of a conventional WTP



Treated Water Augmentation

DPR in most highly engineered form: Introduction of full-advanced-treated purified water into a potable distribution system downstream of a conventional WTP



** Though California regulations allow using tertiary-treated recycled water for groundwater recharge via surface spreading, Valley Water requires full advanced treatment to protect groundwater quality.*

Figure 3-1. California regulations address five specific approaches to potable reuse

Under legislative mandate in Assembly Bill (AB) 574, the State Board is required to develop regulations for RWA by the end of 2023 (with a potential extension to mid-2025). In August 2019, the State Board issued the second edition of its Proposed Framework for Regulating DPR in California, with various updates to their initial draft.

Notably, DDW indicated the intent to develop a single DPR regulatory package that encompasses requirements for both RWA and TWA. The timeline for the DPR regulatory package remains consistent with the AB 574 deadline of December 2023.

Monitoring for CECs such as PFAS is required for potable reuse projects. The proposed treatment trains are effective at removing many CECs, including PFAS, as noted in Valley Water's PFAS fact sheet (Valley Water, 2020b). Valley Water will track regulations and continue to assess potential risk of purified water and CECs to groundwater. Implementation of future groundwater recharge portfolios would include detailed hydrogeologic modeling and monitoring to assess potential for mobilization of constituents, including CECs or metals.

As also noted in the preface, DDW released an initial draft of DPR regulations in March 2021, as Valley Water and its project team were finalizing this CoRe Plan. With initial draft regulations becoming available after a multi-year effort to complete the CoRe Plan—including development of preliminary treatment trains for DPR portfolios (both RWA and TWA) and a regulatory compliance assessment—Valley Water and its project team performed a cursory review of the initial draft regulations and found the anticipated DPR requirements identified in the CoRe Plan adhere closely to those in the draft regulations.

Section 4:

Existing Reuse Systems

Each of the four WWTPs in the County produces recycled water distributed for NPR. In addition, Valley Water's SVAWPC purifies a portion of SJ/SC RWF effluent. The purified water is blended into SBWR's recycled water for salinity reduction.

Before exploring conceptual and feasible water reuse alternatives, Valley Water and the Project Team gathered up-to-date information for recycled water facilities in the County. ***Appendix E (Baseline Analysis TM)*** provides more detail on the approach used to establish existing conditions for the recycled water facilities and distribution systems in the County, as well as the outcomes. This evaluation also included a preliminary assessment of the volume of water available for reuse, the potential NPR/PR split, and a summary of potential infrastructure improvements. The Baseline Analysis helped to inform development of project alternatives and portfolios.

The baseline conditions (physical characteristics and flows) of existing reuse facilities are summarized in the following subsections and inform the analysis of expanded reuse potential. Figure 4-1 shows the extent of existing recycled water distribution systems, as well as water/recycled water retailers' service areas and sewershed boundaries throughout Santa Clara County.

Currently, recycled water systems in the County serve only NPR end uses. The SVAWPC opened in 2014 to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology.

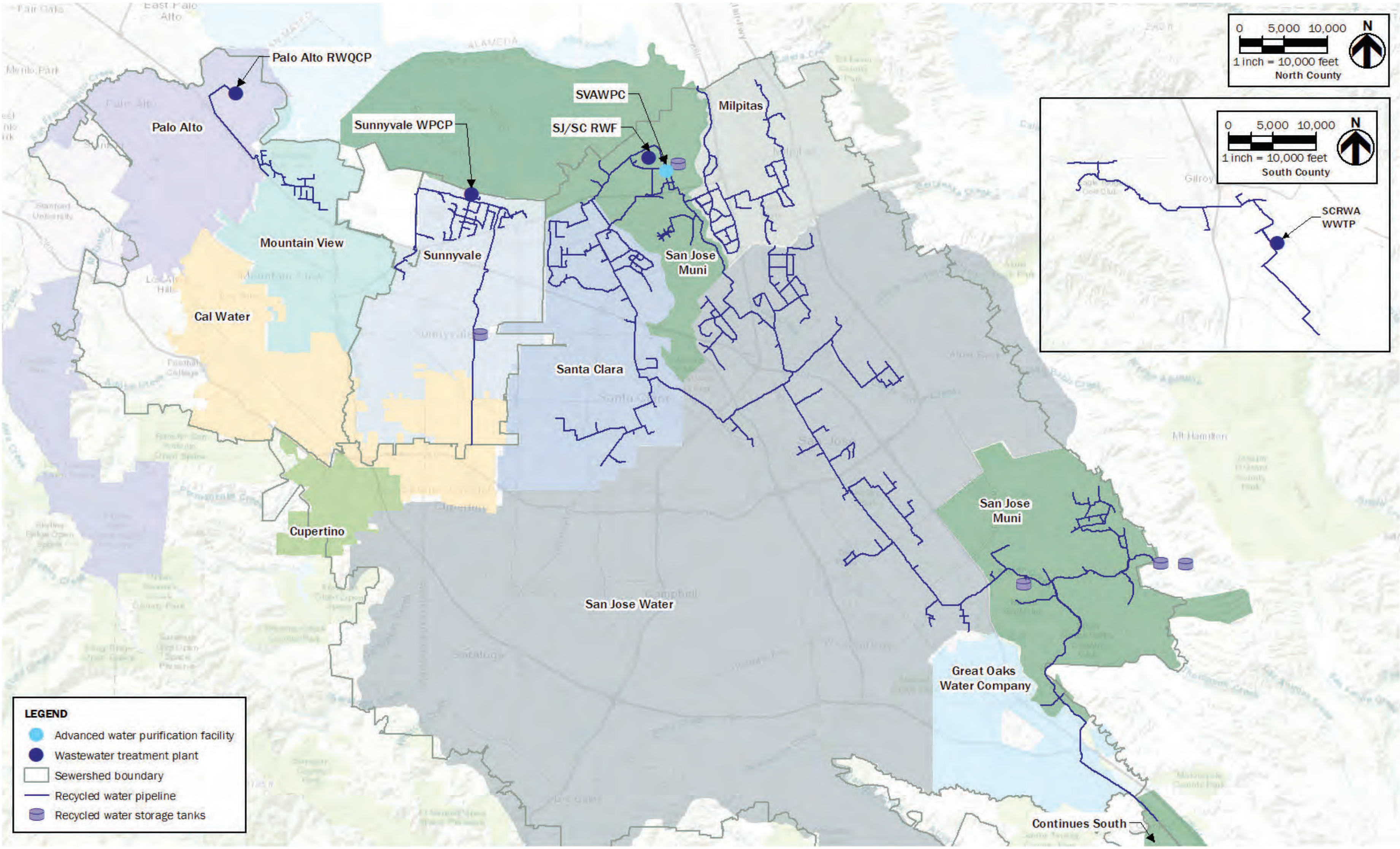


Figure 4-1. Existing recycled water distribution systems, water/recycled water retailer service areas, and sewershed boundaries throughout Santa Clara County

4.1 System Characteristics

Key characteristics of each WWTP and corresponding NPR system are summarized below. Partner Agencies' many planned improvements—including expanded NPR distribution systems and a new AWPF for NPR+ in Palo Alto—align with the CoRe Plan objectives and involve close coordination with Valley Water.

RECYCLED WATER PRODUCERS (WWTPs)

Palo Alto RWQCP, Advanced Secondary Treatment

Average dry weather influent: 18 mgd [a]
NPR production capacity: 5 mgd
Planned improvements: secondary treatment process upgrades (currently in design), parallel outfall (currently in design), headworks, additional recycled water facilities

Sunnyvale WPCP, Tertiary Treatment

Average dry weather influent: 11 mgd [a]
NPR production capacity: 4 mgd
Planned improvements: replacing primary treatment facilities (in construction), rehabilitating secondary and tertiary facilities, converting secondary treatment to conventional activated sludge process (Phase I in design)

SJ/SC RWF, Tertiary Treatment

Average dry weather influent: 102 mgd [a]
NPR production capacity: 38 mgd
Planned improvements: headworks modifications; upgrades to primary and secondary treatment, filtration, and sludge thickening

SCRWA WWTP, Tertiary Treatment

Average dry weather influent: 6 mgd [a]
NPR production capacity: 9 mgd
Planned improvements: addition of a new membrane bioreactor (MBR) process

RECYCLED WATER SYSTEMS (NON-POTABLE REUSE)

Palo Alto/Mountain View RWS

Service area: vicinity of Palo Alto RWQCP and North Bayshore area of Mountain View
NPR demand (peak month): 1 mgd (2015-2017 average); 5 mgd (projected [b])
Current challenges: high salinity, insufficient storage, no potable backup
Planned improvements: distribution system expansion; AWPF for NPR+

Sunnyvale RWS

Service area: Northern Sunnyvale (north of Highway 237) and Apple campus in Cupertino
NPR demand (peak month): 2 mgd (2015-2017 average); 3 mgd (projected [b])
Current challenges: high salinity, color (green tint), insufficient storage
Planned improvements: none planned

SBWR

Service area: San José, Santa Clara, and Milpitas
NPR demand (peak month): 20 mgd (2015-2017 average); 45 mgd (projected [c])
Current challenges: insufficient storage, lack of isolation valves
Planned improvements: maintenance and reliability upgrades

South County RWS

Service area: Gilroy
NPR demand (peak month): 3 mgd (2015-2017 average); 5 mgd (projected [b])
Current challenges: high salinity, no potable backup, peak hour demands near system capacity
Planned improvements: distribution system expansion

PURIFIED WATER FACILITY

Silicon Valley Advanced Water Purification Center (SVAWPC)

Owned and operated by Valley Water, the SVAWPC is located across the street from the SJ/SC RWF in San José. SVAWPC was developed to enhance the quality of SBWR recycled water. SBWR demands are met with a blend of SJ/SC RWF recycled water and purified water from SVAWPC.

SVAWPC employs many treatment processes needed for PR; thus, Valley Water conducts research at the facility to further evaluate purified water as a future water supply option. The current purified water production capacity is 8 mgd.

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[a] *2014-2018 average dry weather influent (i.e., lowest consecutive three-month average) from California Integrated Water Quality System (CIWQS). Sunnyvale WPCP values from CIWQS were reduced by 0.5 mgd to account for a difference in metering location, per direction from Sunnyvale staff.*

[b] *2040 NPR demand projections based on projected annual demands from 2015 Urban Water Management Plans and assuming the same monthly distribution as historical use (2015-2017 average). Values do not fully capture potential allocations per contractual agreements.*

[c] *Updated 2040 NPR demand projections provided by SBWR staff in January 2019. As shown in Figure 4-3, peak summer demands are much higher.*

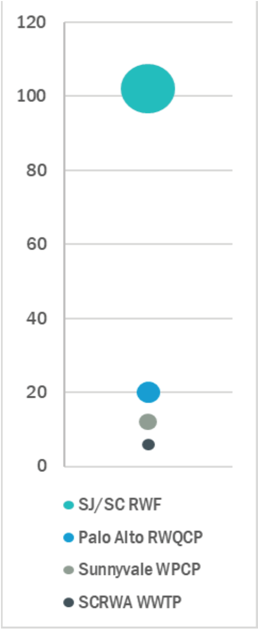
4.2 Existing Flow Conditions

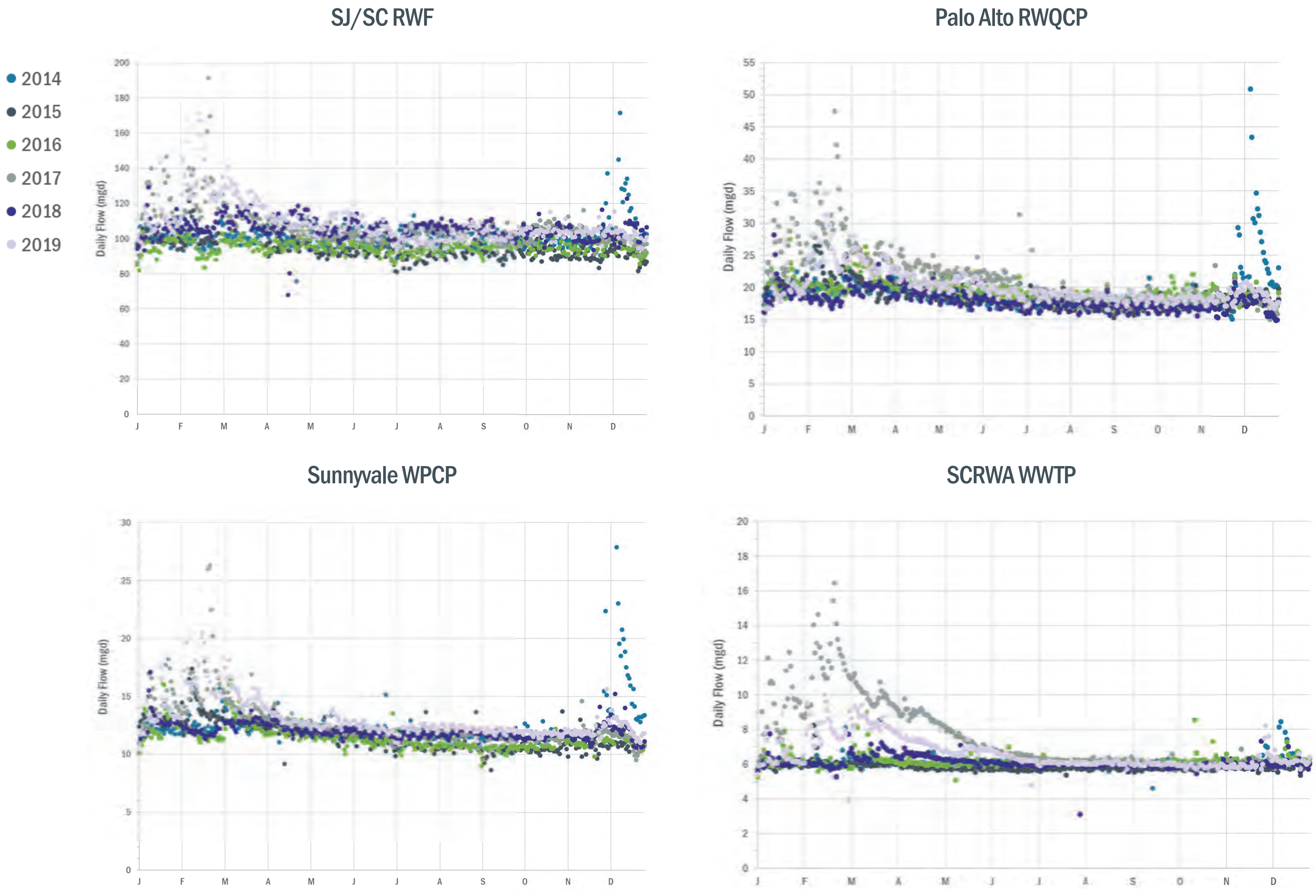
WWTP Influent

Figure 4-2 shows daily influent flows at each of the four WWTPs (2014-2019). Influent varies seasonally, particularly during wet years, with winter flows significantly higher than summer flows. Influent is often characterized as average dry weather flow (ADWF), or the lowest consecutive three-month average, which tends to be much lower than average annual flow.

Flows vary across the four WWTPs, as shown below; thus, scales in Figure 4-2 differ by WWTP.

Scale: Average daily influent flow (in mgd) at Partner Agencies' WWTPs




SJ/SC RWF

Palo Alto RWQCP

Sunnyvale WPCP

SCRWA WWTP

Figure 4-2. Existing flow conditions by Partner Agency, based on daily WWTP influent flows (2014 through 2019)

Note: Scale differs by WWTP.

Source: California Integrated Water Quality System (CIWQS) database (note – Sunnyvale flows were corrected by reducing WPCP influent by 0.5 mgd, per discussion with Sunnyvale staff).

NPR Demands

Average monthly NPR demands (based on 2015-2017 data provided by Partner Agencies) are shown on Figure 4-3. NPR demand tends to be much higher in summer months, as recycled water is largely used for landscape irrigation. To improve water quality and maintain a target TDS below 500 to 550 mg/L, SBWR currently blends purified water from the SVAWPC with its Title 22 recycled water, resulting in reuse supply referred to as enhanced NPR, or NPR+. Palo Alto is planning a local AWPF for NPR+ in the future. Sunnyvale and SCRWA currently do not have a need for NPR+.

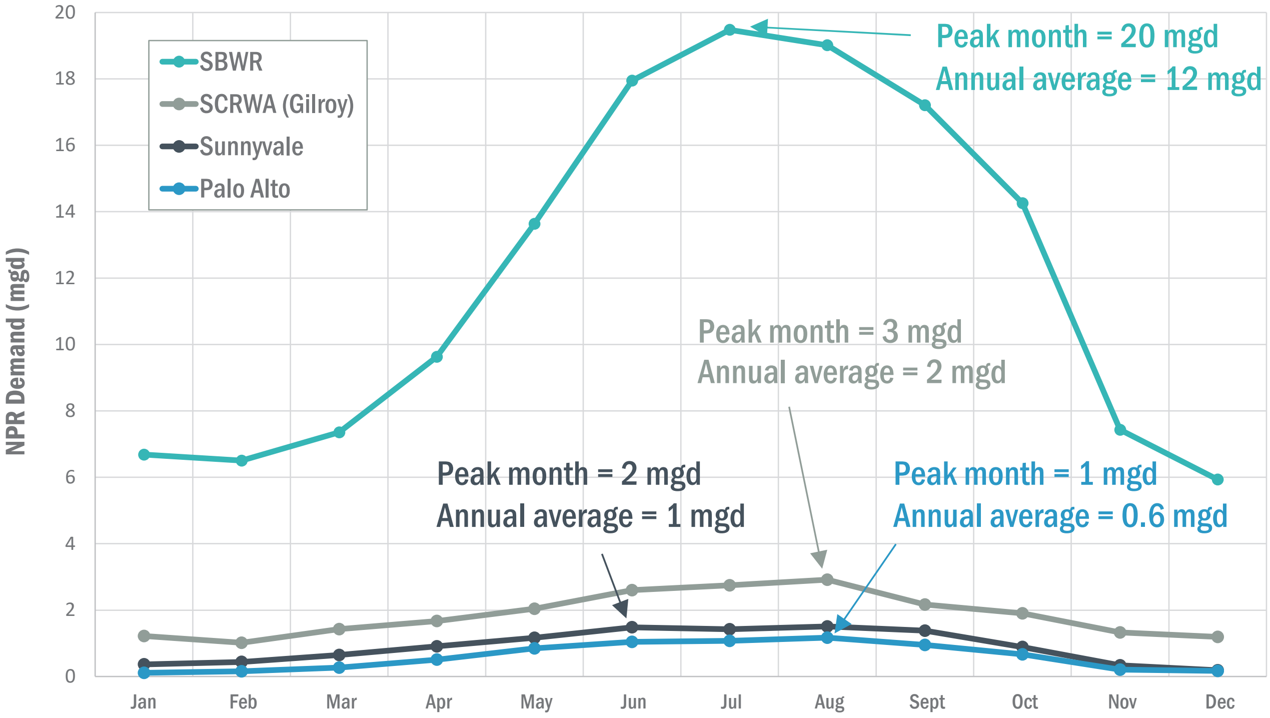


Figure 4-3. Existing NPR demands by Partner Agency, based on average monthly use (2015-2017)

Environmental Flow Requirements

Depending on circumstances, regulatory permits may specify conditions for systems to support ecosystem health by providing environmental flows dictating the quantity, timing, and quality of water flowing to natural systems. Currently, Palo Alto RWQCP is the only WWTP in the County obligated under NPDES permit requirements to provide flow for environmental benefit. While the Palo Alto RWQCP's NPDES permit currently requires 1 mgd of effluent to be sent to the Renzel Marsh project, the marsh may be expanded to receive up to 3 mgd. This consumptive use supports habitat preservation but further reduces effluent available for potential reuse, as described further in Section 5.2.

Losses

Depending on the treatment process, some WWTPs experience losses during treatment. For example, the Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash) and experiences a 20% loss of the recirculated flow, which equates to approximately 0.3 mgd. Additionally, the Sunnyvale WPCP has some evaporative losses associated with the use of ponds as part of its treatment process. Current evaporative losses are typically between 1 and 2 mgd, though future losses may be up to 4 mgd, including flows for capping and evaporation at their ponds.

4.3 Reuse Research Facilities

In 2014, Valley Water commissioned the SVAWPC, an 8-mgd (vs. 8.0-mgd) state-of-the-art advanced water treatment facility that includes microfiltration, reverse osmosis (RO), and ultraviolet (UV) light disinfection. A pilot-scale advanced oxidation process is also part of the facility, used to test and demonstrate the continued performance of advanced treatment technologies for producing highly treated water (purified water) to be used for IPR and/or potential DPR applications. The facility provides an excellent venue for both IPR and DPR public education. The 2015 PR Demonstration Test Plan prepared by Valley Water demonstrated effective performance of the SVAWPC to further advance secondary treated wastewater to meet or exceed California drinking water standards. Figure 4-4 shows key results of this study.

- Treatment processes for purification met performance requirements
- Treatment processes confirmed removal of pathogens and CECs
- Water purified with advanced oxidation meets all California drinking water standards
- New monitoring approaches were proven to accurately verify removal of pathogens and contaminants
- Critical control points (parameters that will demonstrate water quality that meets regulations) were identified
- Staff gained valuable understanding of what changes are important for the future production of purified water

Figure 4-4. Key results of the PR demonstration test plan for SVAWPC

In 2017, Valley Water initiated studies and a planning effort to evaluate viable alternatives for managing ROC from potential advanced water purification facilities that could be built in the County. Together with the University of California Berkeley, NSF Engineering Research Center for Reinventing the Nation's Urban Water Infrastructure, Stanford University, and the San Francisco Estuary Institute, Valley Water studies treatment alternatives by installing, testing, and evaluating a pilot-scale engineered open-cell treatment system at the SVAWPC.

Independent of Valley Water's efforts, Stanford University is currently operating a water reuse research facility in Palo Alto called the Codiga Resource Recovery Center. The center has the flexibility to evaluate multiple mobile treatment systems and to vary feed water quality (lake water, greywater, municipal wastewater [raw sewage], primary effluent, and secondary effluent). The flagship treatment technology is a staged anaerobic fluidized bed membrane bioreactor that treats municipal wastewater to secondary effluent water quality standards and converts organic matter to biogas methane. Benefits of this technology include decreased energy use by avoiding aeration and reduced solids handling costs. The center is also evaluating forward osmosis/RO technology first developed by NASA. Currently, all effluent is returned to the sewer for treatment at the Palo Alto RWQCP.

The successful operation of the SVAWPC, along with these advanced technology and research studies, establishes a foundation to provide regional discussions on the feasibility and development of PR projects.

Section 5:

Expanded Reuse Potential

Valley Water's strategy for improving water supply reliability through water reuse is twofold: (1) Integrate and expand existing NPR systems; (2) Develop purified water systems within the County.

Expanded reuse potential—including NPR and PR—was evaluated in partnership with recycled water producers, wholesale and retail water suppliers, end users, regulatory agencies, and other interested parties.

5.1 Projected NPR Demands

Expansion of NPR is a key component of the CoRe Plan, as all four Partner Agencies anticipate increased NPR demand in their service areas. The CoRe Plan assumes that NPR demands will be met before remaining effluent is made available for potable reuse.

Based on the planning horizon for the CoRe Plan, 2040 was used as the timeframe for estimating future flow availability. Water suppliers developed their 2015 Urban Water Management Plans (UWMP)[6] in coordination with recycled water producers and generally contain the most recent NPR demand forecasts. Thus, 2015 UWMPs were used as the basis for future NPR projections with a few exceptions:

- In January 2019, SBWR provided updated recycled water projections that reflect increased NPR+ demand in areas served by the City of Santa Clara and San José Municipal Water (Table 5-1).
- Morgan Hill's 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible under a more integrated regional context, the CoRe Plan uses Morgan Hill's conceptual NPR buildout demands from the 2015 South County Recycled Water Master Plan Update.

NPR demand projections by Partner Agency, as summarized in Table 5-1, do not fully capture potential allocations per contractual agreements. For example, Mountain View is contractually entitled to peak flows of up to 3 mgd of recycled water from Palo Alto, though projected NPR demand is less than 3 mgd on average. The CoRe Plan assumes future NPR usage aligns with projected demand, though contractual obligations are considered in the context of project feasibility and implementation as effective limitations on the amount of effluent available for PR.

Although future NPR projections are provided as annual estimates, NPR use varies seasonally. A monthly distribution factor, based on actual NPR data from 2015-2017, was applied to 2040 projections to estimate future monthly NPR demand.

All four Partner Agencies anticipate increased NPR demand in their service areas. The CoRe Plan assumes that NPR demands will be met before remaining effluent is made available for potable reuse.

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[6] UWMPs are currently in process of revision and, upon completion (anticipated by mid-2021), will include updated NPR demands.

Table 5-1. Summary of Projected Long-Term NPR Demands by Recycled Water System

Recycled Water System	Recycled Water Retailers	2040 NPR Demand mgd (annual average)	2040 NPR Demand AFY[a]	Current Contractual Obligation[b]
PA/MV RWS	Palo Alto Mountain View	2.5	2,800	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	Sunnyvale Cal Water (Cupertino) San Jose Water (Cupertino)	1.5	1,700	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	Santa Clara San José Municipal Water San Jose Water Milpitas	27.6 [c, d]	30,900 [c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless a new agreement is established)
SCRWA	Gilroy Morgan Hill	3.3 2.6	3,700 2,900[e]	Per the existing agreement, SCRWA may sell other wholesalers recycled water available in excess of the annual delivery quantity—a flow mutually determined by SCRWA and Valley Water and established each year, and Valley Water may sell recycled water to end users outside of the South County RWS service area (with SCRWA's concurrence)
Countywide	**Total, excluding Morgan Hill** **Total, including Morgan Hill**	**34.9** **37.5**	**39,100** **42,000**[e]	

a. *Projected 2040 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY, except for SBWR and the City of Morgan Hill—see notes (c) and (e).*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

c. *Reflects updated NPR demands provided by SBWR staff in January 2019.*

d. *Annualized flow is 27.6 mgd; peak month demands are likely to be significantly greater. For example, the 2014 SBWR Strategic Master Plan identifies an average 2040 NPR demand of 34 mgd and peak month demand of 49 mgd.*

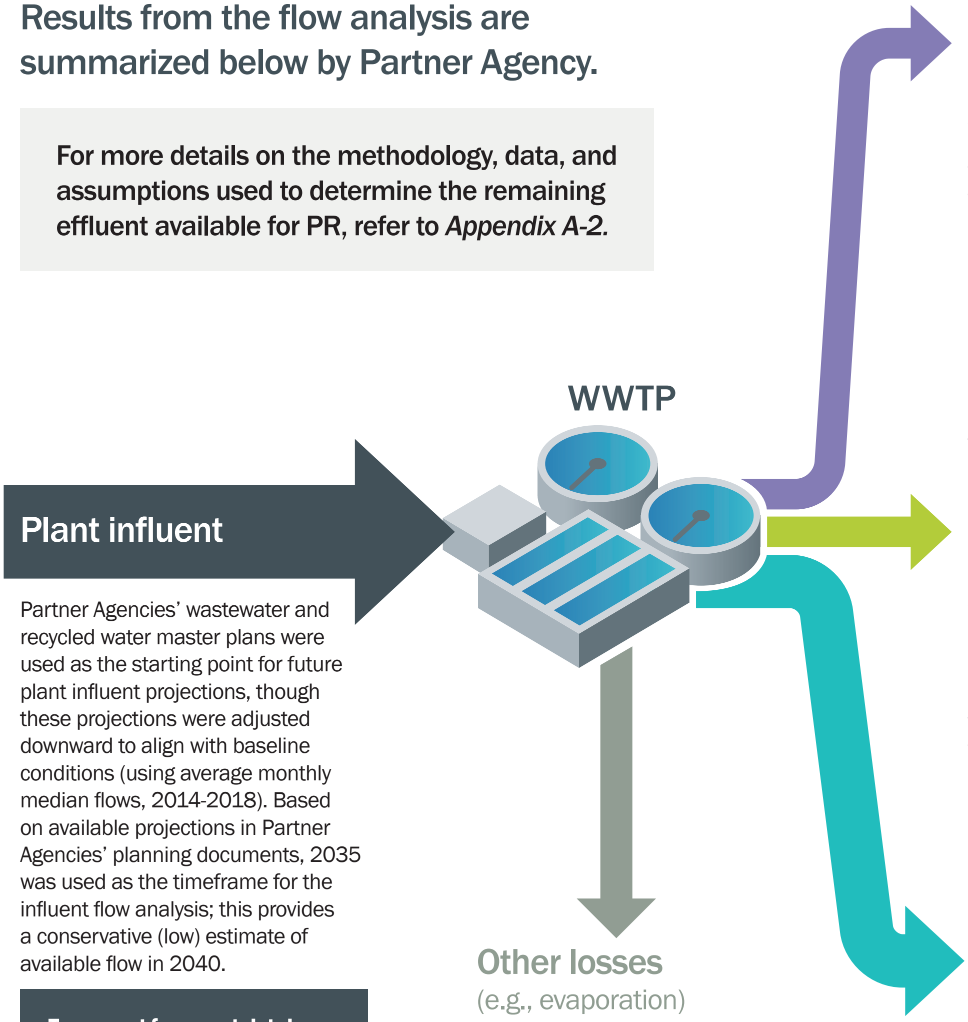
e. *Reflects Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

5.2 Available Source Water for Potable Reuse

In addition to NPR, some WWTP effluent is reserved for other uses, such as for environmental benefit. Figure 5-1 shows a flow balance for typical WWTP that accounts for various flow streams. The Project Team completed a flow balance for each Partner Agency WWTP to estimate the remaining effluent available for discharge, blending, or additional reuse in 2040. Because NPR expansion is already planned by each Partner Agency, the CoRe Plan assumes projected NPR demands will remain intact, and PR projects will be sourced by remaining effluent (minus any effluent reserved for discharge, blending, or other requirements).

Results from the flow analysis are summarized below by Partner Agency.

For more details on the methodology, data, and assumptions used to determine the remaining effluent available for PR, refer to *Appendix A-2*.



Plant influent

Partner Agencies' wastewater and recycled water master plans were used as the starting point for future plant influent projections, though these projections were adjusted downward to align with baseline conditions (using average monthly median flows, 2014-2018). Based on available projections in Partner Agencies' planning documents, 2035 was used as the timeframe for the influent flow analysis; this provides a conservative (low) estimate of available flow in 2040.

To account for uncertainty in future influent projections, a range of flows was considered:

- **The "lower bound" assumes no increase from baseline (flatlined projection).**
- **The "upper bound" assumes same slope (i.e., rate of increase) from Partner Agencies' planning documents.**

Other losses
(e.g., evaporation)

In general, treatment losses at the WWTPs were assumed to be negligible, unless otherwise specified by Partner Agency staff. Future losses considered 0.3 mgd lost from recirculated flow at the Palo Alto RWQCP and 4 mgd reserved for evaporation and capping at the Sunnyvale WPCP.

Non-potable
(including in-plant uses)

As described in Section 5.1, retailers' 2015 UWMPs served as the source for projected NPR demand, except for SBWR (whose staff provided updated demands in January 2019) and Morgan Hill (conceptual buildout demand from 2015 South County Recycled Water Master Plan Update). For the three North County systems (SBWR, Palo Alto, and Sunnyvale), additional losses associated with NPR+ (i.e., ROC from advanced treatment) were considered.

Environmental flow requirements

The flow analysis assumed 3 mgd of effluent from the Palo Alto RWQCP will be used to meet environmental flow requirements in 2040, including flows to Renzel Marsh. No environmental flow requirements have been identified for the SJ/SC RWF, Sunnyvale WPCP, or SCRWA WWTP. Flow availability may be impacted if environmental flow requirements are identified.

Remaining effluent

Remaining effluent (i.e., WWTP influent minus losses, environmental flows, and effluent needed to meet NPR demands) may be available for discharge, blending, or additional reuse. Currently, remaining effluent in North County is discharged to the San Francisco Bay, while remaining effluent in South County is sent to percolation ponds or discharged to the Pajaro River (and eventually Monterey Bay). For this planning-level estimate, it was assumed that all remaining effluent was available for PR, and potential AWPFs were sized accordingly.

Figure 5-1. Typical WWTP flow balance

5.2.1 SJ/SC RWF Flow Analysis

Figure 5-2 displays future WWTP influent projections and effluent needed to meet SBWR's future NPR+ projections through 2040. Because no environmental flows or other losses were identified for the SJ/SC RWF, the remaining effluent available for discharge, blending, or additional reuse is calculated simply as the difference between the projected WWTP influent flows and NPR+ demands and estimated at 71 to 79 mgd on average (based on the range of influent projections). Wastewater availability may be impacted if environmental flow requirements are identified in the future.

The estimated remaining effluent available exceeds the 30.4 mgd AWPF feed flow needed to produce 24 mgd of purified water (considering treatment losses and a 90% online factor) and achieve Valley Water's goal of developing 24,000 AFY for PR. Despite seasonal flow variability, historical influent data suggest the SJ/SC RWF has sufficient effluent to typically produce 24 mgd of purified water year-round, though some effluent may be needed for future discharge, blending, or other uses.

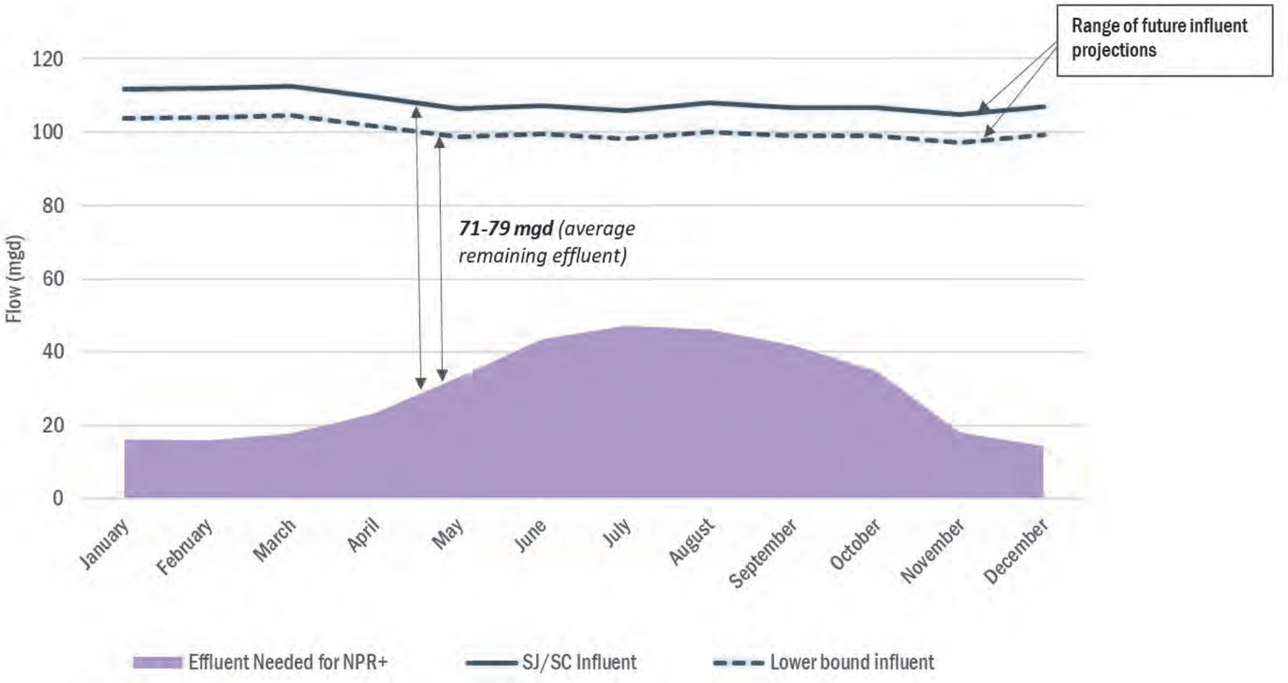


Figure 5-2. Projected flow conditions at SJ/SC RWF considering future influent projections and SBWR NPR+ demands

5.2.2 Palo Alto RWQCP Flow Analysis

The remaining effluent available from the Palo Alto RWQCP is projected to be 13.3 to 15.3 mgd on average (based on the range of influent projections) as shown in Figure 5-3, which displays future influent projections, effluent needed to serve Palo Alto and Mountain View NPR+ demands in 2040, environmental flows (3 mgd), and losses (0.3 mgd).

On its own, the Palo Alto RWQCP does not have sufficient effluent available to produce 24 mgd of purified water. Based on available flows, an AWPF in Palo Alto would be sized at 14 mgd (84% efficiency under "upper bound" conditions). Under "lower bound" conditions, the AWPF would be downsized to 12 mgd to maintain 84% efficiency. AWPF efficiency accounts for the online factor (90% assumed for all facilities) as well as source water availability (projected to be lower in Palo Alto and Sunnyvale than San José). More details on AWPF sizing and utilization are included in ***Appendix A-2***.

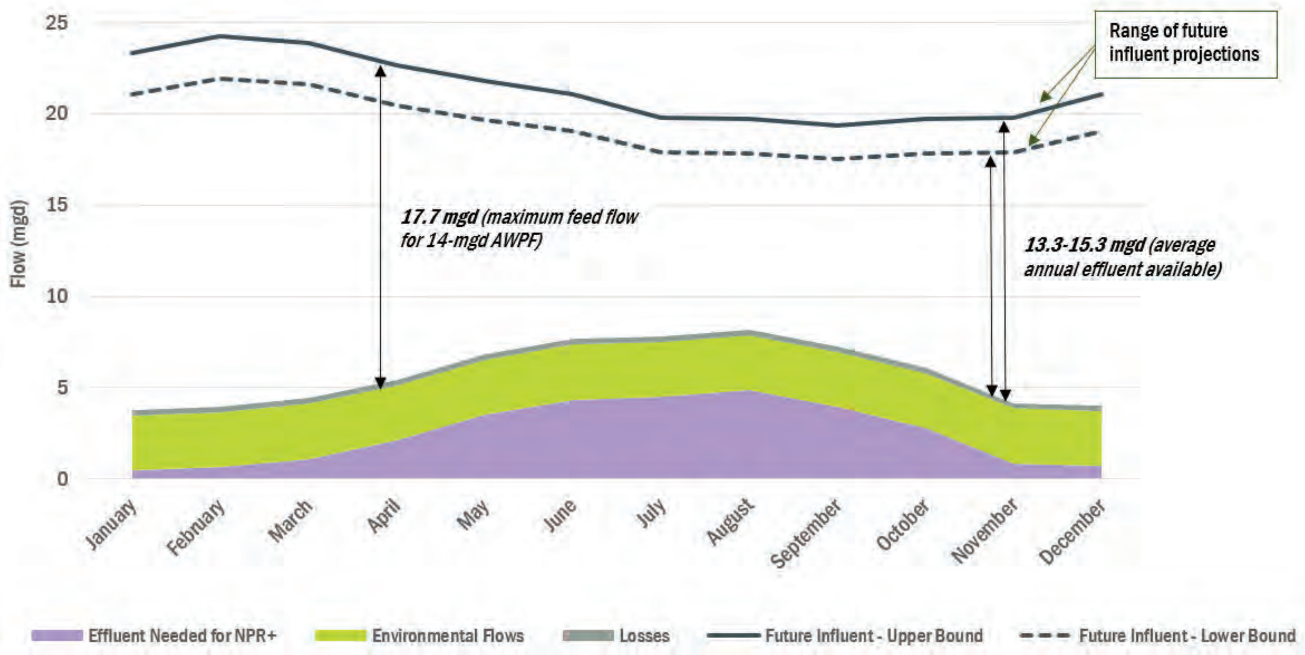


Figure 5-3. Projected flow conditions at Palo Alto RWQCP considering future influent projections and Palo Alto/Mountain View NPR+ demands

5.2.3 Sunnyvale WPCP Flow Analysis

Figure 5-4 displays future influent projections, effluent needed for NPR+, and losses from evaporation and capping associated with Sunnyvale's treatment ponds (4 mgd). No environmental flow requirements are identified for Sunnyvale WPCP. The remaining effluent available is projected to be at least 5 mgd on average.

On its own, the Sunnyvale WPCP does not have sufficient effluent available to produce 24 mgd of purified water. Based on available flows, an AWPF in Sunnyvale would be sized at 10 mgd (88% efficiency under "upper bound" conditions). Under "lower bound" conditions, the AWPF would be downsized to 6 mgd (81% efficiency). Under "upper bound" conditions, Sunnyvale and Palo Alto combined could produce 23,000 AFY of purified water for PR (after accounting for treatment losses and the 90% online factor).

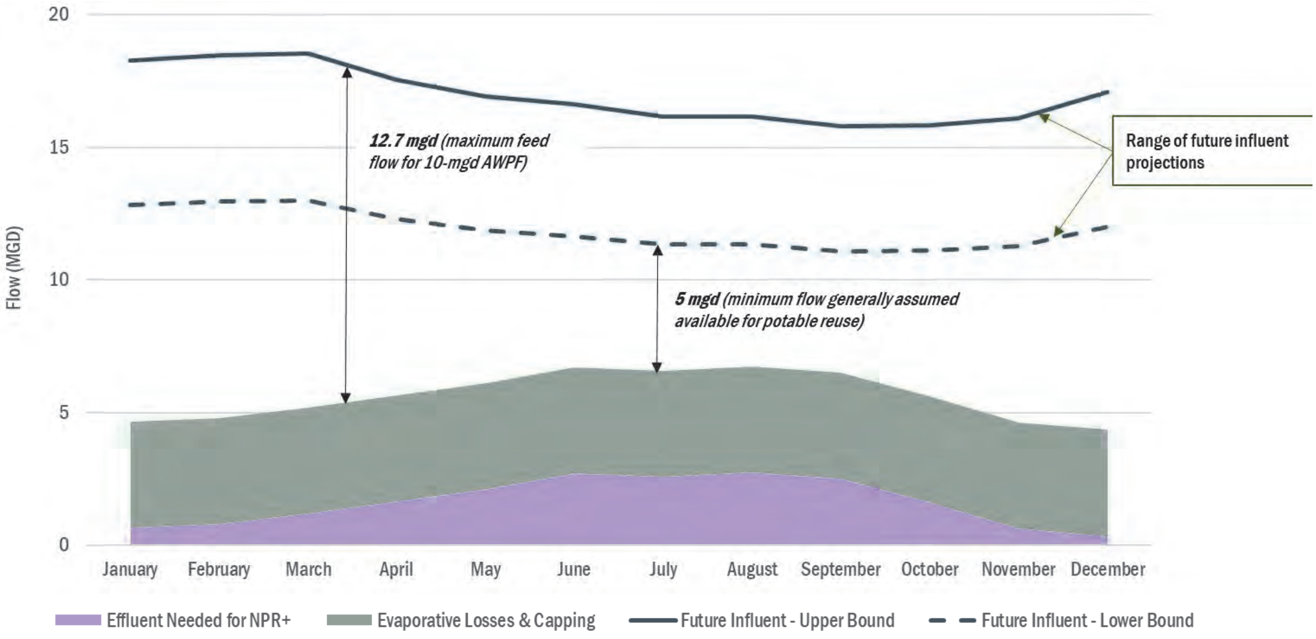


Figure 5-4. Projected flow conditions at Sunnyvale WPCP considering future influent projections and NPR demands

5.2.4 SCRWA WWTP Flow Analysis

SCRWA WWTP influent remained relatively consistent over the past several years (ADWF = 6 mgd) and is projected to be similar in the future. Unlike the WWTPs in North County, only one set of influent projections was considered for SCRWA.

As shown on Figure 5-5, SCRWA WWTP receives wastewater from two cities: Gilroy and Morgan Hill. Currently, NPR is only delivered in Gilroy. During the summer months, a portion of wastewater from Morgan Hill is needed to supply NPR in Gilroy. On average, 3 mgd of remaining effluent is available from SCRWA WWTP. However, if considering satellite treatment in Morgan Hill, only 2.1 mgd of Morgan Hill's wastewater would be available on average, with minimal flow available in the summer months (when needed to supply NPR in Gilroy).

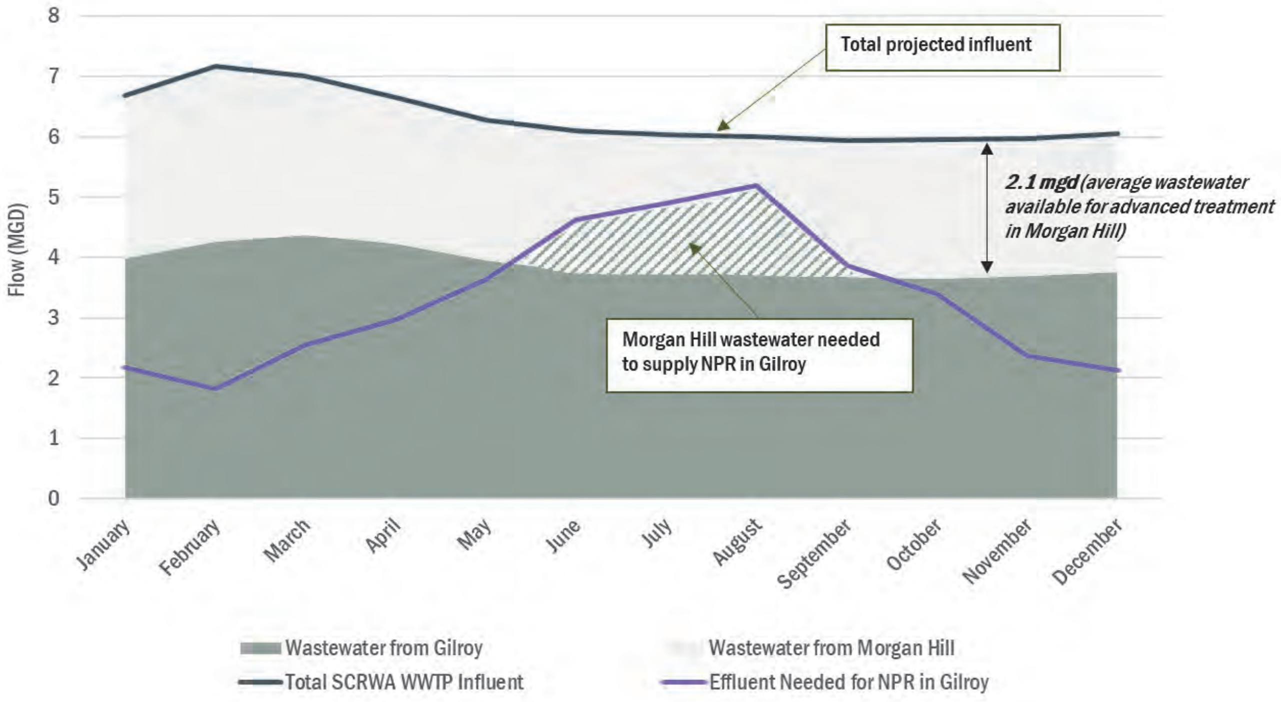


Figure 5-5. Projected flow conditions at SCRWA's WWTP considering future influent projections and South County RWS NPR demands

5.2.5 Summary

Anticipated purified water yields (after treatment losses) are shown in Table 5-2. These values are based on estimated source water availability and do not account for potential limitations at the delivery point (e.g., groundwater basin capacity), which may limit PR in wet years. Annual yields are estimated for planning purposes and cannot be guaranteed.

More details on estimated flows, including summaries of projected monthly flows by Partner Agency and AWPF sizing calculations, are included in ***Appendix A-2***.

Table 5-2. Potential Annual Yield for Potable Reuse Considering Source Water Availability by Producer

Facility	Potential Yield (AFY) [a]
San José AWPF	24,000
Palo Alto AWPF	11,700 – 13,200
Sunnyvale AWPF	5,500 – 9,800
Palo Alto and Sunnyvale (combined)	17,300[b] – 23,000
Morgan Hill Satellite AWPF	1,900

a. *Discussions around source water availability and potential purified water yield are ongoing. Yield may be lower during drought conditions or other scenarios.*

b. *Lower bound for Palo Alto AWPF and Sunnyvale AWPF, when shown separately, differ from combined total due to rounding.*

5.3 Onsite Reuse Considerations

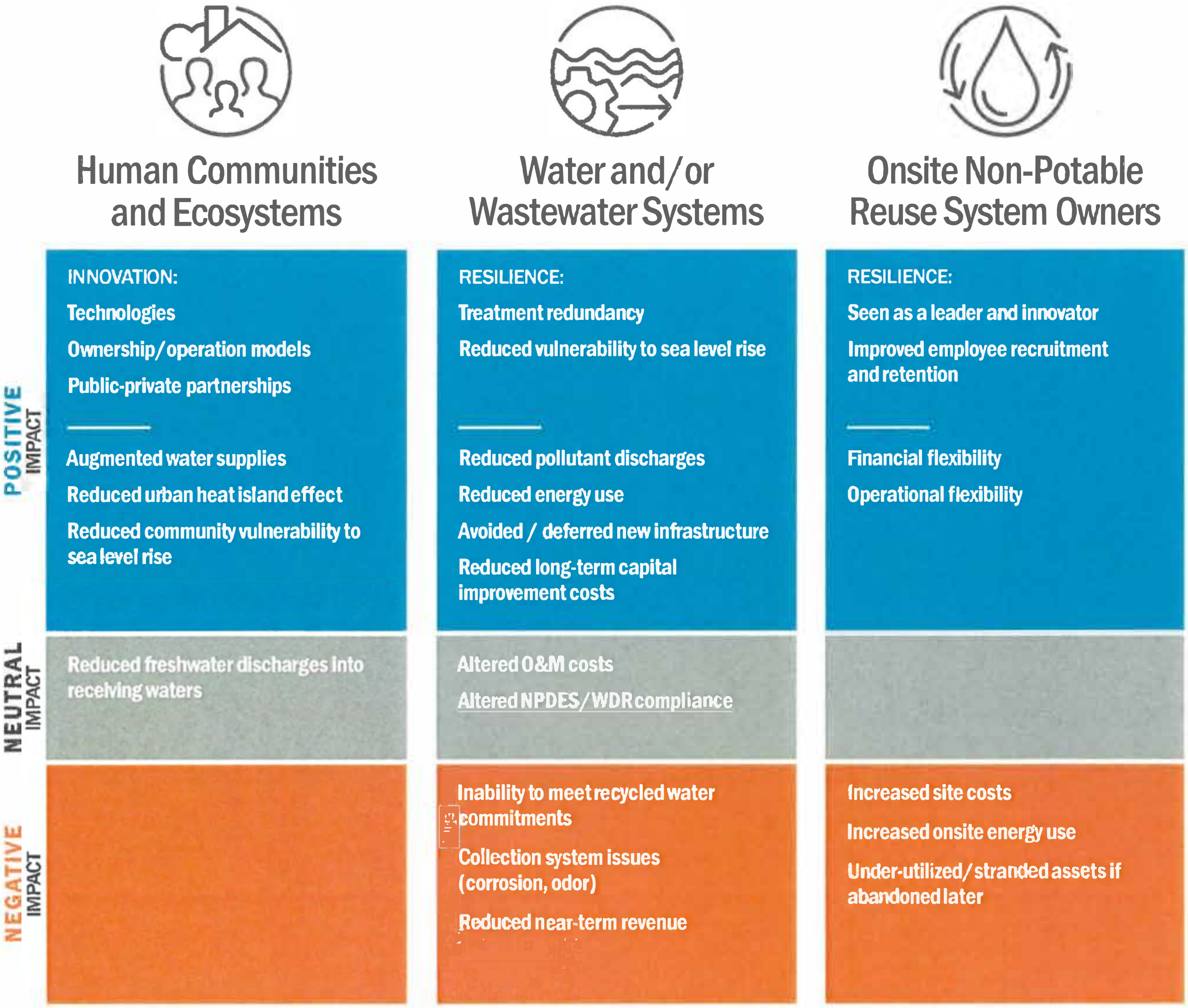
Onsite reuse systems are decentralized building-scale or neighborhood-scale wastewater treatment or rainwater harvesting systems.

Onsite non-potable reuse systems in the County may have future implications for centralized reuse facilities. Onsite reuse offers benefits to system owners, such as improving resilience/resource independence and meeting sustainability goals. Benefits to surrounding centralized water and wastewater infrastructure systems include reducing the long-term need for new water supply/treatment or wastewater infrastructure, increasing green space, and enhancing water supply reliability. However, if not implemented in close coordination with local water and wastewater agencies, onsite reuse projects may have negative impacts, including reduced wastewater availability for centralized reuse projects, concentrated wastewater streams (prompting corrosion and/or odor concerns), and/or stranded or underutilized assets.

The Project Team surveyed the Partner Agencies to collect information on existing and/or planned onsite reuse systems in the County, planned approaches for permitting onsite reuse systems, and perspectives on current and future onsite reuse. Onsite reuse is not yet prevalent within the County: four onsite reuse projects are under development in Mountain View and potential additional projects are being explored elsewhere in the County.

The Pacific Institute recently released *The Role of Onsite Water Systems in Advancing Water Resilience in Silicon Valley* (Pacific Institute, 2021). The authors interviewed 23 stakeholders in Silicon Valley that are working on onsite reuse and gleaned potential outcomes and impacts (positive and negative) associated with onsite reuse systems, as summarized in Figure 5-6.

Future onsite reuse efforts will require coordination among multiple stakeholders, including Valley Water and the Partner Agencies, to evaluate potential impacts on centralized NPR and PR projects. With mindful implementation, onsite reuse could provide an opportunity to forge innovative public-private partnerships and advance reuse in locations lacking in proximity to existing and planned recycled water systems.



	Human Communities and Ecosystems	Water and/or Wastewater Systems	Onsite Non-Potable Reuse System Owners
POSITIVE IMPACT	INNOVATION: **Technologies** **Ownership/operation models** **Public-private partnerships** — **Augmented water supplies** **Reduced urban heat island effect** **Reduced community vulnerability to sea level rise**	RESILIENCE: **Treatment redundancy** **Reduced vulnerability to sea level rise** — **Reduced pollutant discharges** **Reduced energy use** **Avoided / deferred new infrastructure** **Reduced long-term capital improvement costs**	RESILIENCE: **Seen as a leader and innovator** **Improved employee recruitment and retention** — **Financial flexibility** **Operational flexibility**
NEUTRAL IMPACT	**Reduced freshwater discharges into receiving waters**	**Altered O&M costs** **Altered NPDES/WDR compliance**	
NEGATIVE IMPACT		**Inability to meet recycled water commitments** **Collection system issues (corrosion, odor)** **Reduced near-term revenue**	**Increased site costs** **Increased onsite energy use** **Under-utilized/stranded assets if abandoned later**

Figure 5-6. Anticipated outcomes and impacts of onsite non-potable reuse systems in Santa Clara County

Source: Adapted from Role of Onsite Water Systems in Advancing Water Resilience in Silicon Valley (Pacific Institute, 2021)
Note: Realization of outcomes and impacts, both positive and negative, are depend on local context and extent of onsite reuse implementation.

Section 6:
Project Portfolios

Rather than recommending a single alternative, the CoRe Plan holistically considers reuse opportunities and associated implementation feasibility, benefits, challenges, risks, and costs relative to one another.

Groups of project elements (advanced treatment facilities and conveyance infrastructure) are referred to as "portfolios" in the North County and "options" in the South County. The nomenclature implies the flexibility of potentially combining a South County option with any North County portfolio. The process of defining the portfolios and options was iterative and collaborative, as described in this section and in more detail in ***Appendix A-1*** (Feasible Project Portfolios).

6.1 Conceptual Alternatives/Portfolios

Beginning in 2018, the Project Team created groups of projects and packaged them into five conceptual portfolios (formerly called alternatives) that are consistent with guiding principles agreed upon by the Valley Water and Partner Agencies, including:

1. Leverage existing infrastructure where possible
2. Reflect a mix of NPR/NPR+ and PR projects, including potential TWA concepts as a point of comparison for cost-effectiveness
3. Expand Countywide reuse (NPR and/or PR) using source water from each Partner Agency
4. Consider previously explored projects (but not previously deemed infeasible, unless circumstances have changed) and new projects
5. Aim to develop at least 24,000 AFY of PR supply by 2028 to meet the County's water supply demands (consistent with Valley Water's WSMP 2040)

In coordination with Valley Water and its Partner Agencies, the Project Team evaluated the five conceptual portfolios and narrowed down to three portfolios, defined by AWPF source water and location, to develop through preliminary design and comparatively evaluate based on key attributes, differentiators, and factors critical to implementation.

Five Portfolios Conceptually Explored →

Five conceptual portfolios framed at a high level and evaluated using the following criteria: economics, groundwater management and Countywide (regional) supply reliability, environmental impacts/benefits and sustainability, ease of implementation and permitting/regulatory considerations, and engineering feasibility.

Three Portfolios Selected

Three portfolios feature a variety of project elements developed through preliminary design and evaluated for feasibility. Defined by source of supply and treatment facility location, the three portfolios include:

Portfolio 1: San José AWPF

Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF

Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs

Appendix F (Conceptual Alternatives TM) describes in detail the process of developing and assessing the five conceptual portfolios. After narrowing from five to three portfolios, the Project Team developed conceptual (10%) designs for each portfolio, including some permutations, and added new project elements, including different options for South County and potential future TWA concepts. North County portfolios and South County options are described in this section, and all other elements are described in Section 7.

6.2 Feasible Portfolios

The programmatic approach for the CoRe Plan considers a wide range of reuse opportunities for flexible implementation. Project elements, including AWPFs and conveyance/distribution infrastructure, can be combined in a variety of ways to create CoRe portfolios for comparison on an economic, regulatory, institutional, and environmental basis. Project elements are presented and evaluated in groups:

- **NPR/NPR+ distribution system expansion** applies consistently across all portfolios and, therefore, is not considered a differentiator in the portfolio evaluation.
- **South County reuse options** can be included in combination with any portfolio, and therefore are evaluated separately from the portfolios.
- **Baseline elements** comprise each portfolio and are evaluated collectively by portfolio.
- **Alternative elements** are opportunities that have been explored and remain separate from portfolios, as possible “add-on” items or substitutions (e.g., alternative alignments). These elements are included for consideration due to their potential benefits, though they are not included in the evaluation, which focuses on comparing the differences among portfolios. Alternative elements are described in Section 7.

An overview of North County portfolios and South County options is shown in Table 6-1, while key highlights are included in the following subsections. All AWPFs considered in this plan involve treatment using reverse osmosis membranes, resulting in the production of ROC. Strategies for managing ROC at each AWPF are summarized following each portfolio.

Table 6-1. Programmatic Approach for Evaluating Reuse Opportunities

	North County Portfolios		South County Options
Countywide Expansion of NPR/NPR+ (Recycled Water Distribution Systems)	San José	One AWPF in San José **1a:** SJ GWR **1b:** SJ RWA **1c:** SJ TWA, Milpitas Pipeline **1d:** SJ TWA, new pipeline	**MH-1:** NPR+ **MH-2:** GWR **MH-3:** SWA
	Palo Alto & Sunnyvale	One regional AWPF with combined flows from Palo Alto and Sunnyvale **2a:** PA (+SV) GWR **2b:** SV (+PA) GWR	
		Two separate AWPFs in Palo Alto and Sunnyvale **4:** PA/SV GWR	
Alternative Elements and Future Opportunities **Alternative pipeline alignments, interties, and delivery points. Resized designs. Additional TWA opportunities.**			

Highlights of each portfolio follow below, based on preliminary designs. Cost estimates reflect Association for the Advancement of Cost Engineering (AACE) International's Class 5 criteria. Class 5 estimates have an expected accuracy range of -50% to +100%. While the accuracy range is not reflected in values presented in this section, a graphical representation of the level of accuracy is provided in Section 6.4. Section 8 provides potential implementation challenges for each portfolio/option. More detail related to the portfolios and options (e.g., preliminary designs and cost estimates) is included in ***Appendix A.***

6.2.1 San José (SJ) Portfolio

The SJ Portfolio is centered on using available effluent from the SJ/SC RWF to feed a new AWPF adjacent to the existing SVAWPC. Key features, costs, and ROC management assumptions for SJ Portfolio variations are summarized in Tables 6-2 to 6-5, while Figures 6-1 to 6-4 show their respective facility locations and pipeline alignments.

Table 6-2. Portfolio 1a (SJ GWR) Key Features and Costs

1a: SJ GWR Highlights 24 mgd AWPF **Location:** San José **Use:** GWR at LGRP	**Capital Cost:** $655M* **Annual O&M Cost:** $21.4M* **Levelized Unit Costs** • **30-Year Life Cycle:** $2,600-$3,200/AF* • **100-Year Life Cycle:** $2,100-$2,600/AF* **Projected 2040 Yield:** 19,000-24,000 AFY **Pipeline Length/Diameter** • 0.4 miles at 60” • 18.1 miles at 48”	**BENEFITS** SJ/SC RWF flows do not limit projected yield. SVAWPC staff could potentially support new AWPF operation due to proximity. **LIMITATIONS** Minimum flow guarantee for source water requires a long-term agreement with San José. Risks to available yield include drought, environmental needs/impacts, and operations. LGRP recharge potential may limit future yield.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy, based on the Evaluation of ROC Management Options Final Report. Unit costs reflect ROC management and potential 2040 yield ranges.*

Table 6-3. Portfolio 1b (SJ RWA) Key Features and Costs

1b: SJ RWA Highlights

24 mgd AWPF

Location: San José

Use: RWA at Penitencia WTP

Capital Cost: $650M*

Annual O&M Cost: $24.5M*

Levelized Unit Costs

- 30-Year Life Cycle: $2,700-$3,300/AF*
- 100-Year Life Cycle: $2,300-$2,700/AF*

Projected 2040 Yield:

- 19,800-24,000 AFY

Pipeline Length/Diameter

- 0.4 miles at 60”
- 8.9 miles at 48”

BENEFITS

SJ/SC RWF flows do not limit projected yield. Purified water would be delivered to Penitencia WTP for RWA. From there, existing infrastructure could support operational flexibility, such as delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems), pending regulatory approval.

LIMITATIONS

Minimum flow guarantee for source water requires a long-term agreement with San José. Risks to available yield include drought, environmental needs/impacts, and operations. Consistent with Valley Water’s WSMP 2040, assuming DPR water is first-priority supply for Penitencia WTP, blending with raw water. If assumption changes, Penitencia WTP’s capacity may limit potable reuse yield. Further evaluation and coordination needed to confirm acceptability of purified water blending ratio.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy, based on the Evaluation of ROC Management Options Final Report. Unit costs reflect ROC management and potential 2040 yield ranges.*

Table 6-4. Portfolio 1c (SJ TWA, Milpitas Pipeline) Key Features and Costs

1c: SJ TWA (Milpitas Pipeline) Highlights

24 mgd AWPF

Location: San José

Use: TWA (via existing Milpitas Pipeline to Piedmont Valve Yard)

Capital Cost: $555M*

Annual O&M Cost: $24.1M*

Levelized Unit Costs

- 30-Year Life Cycle: $2,500/AF*
- 100-Year Life Cycle: $2,100/AF*

Projected 2040 Yield:

- 24,000 AFY

Pipeline Length/Diameter

- 0.4 miles at 60”
- 3.9 miles at 36”
- 4.7 miles at 24”

BENEFITS

SJ/SC RWF flows do not limit projected yield. Northern parts of Santa Clara and San José could receive TWA to supplement water supply. For other water retailers, purified water would flow south through Milpitas Pipeline, serving several upstream of Piedmont Valve Yard, before blending with other treated supplies and distributing via the East Pipeline. Existing infrastructure could support potential operational flexibility, such as delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems), pending regulatory approval.

LIMITATIONS

Minimum flow guarantee for source water requires a long-term agreement with San José. Risks to available yield include drought, environmental needs/impacts, and operations. Using the Milpitas Pipeline to convey purified water precludes independent use of an emergency connection to SFPUC’s system, via the Milpitas Intertie (northern end of Milpitas Pipeline). Further evaluation and coordination needed to confirm acceptability of purified water blending ratio.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy, based on the Evaluation of ROC Management Options Final Report. Unit costs reflect the ROC management range as a single value due to rounding.*

Table 6-5. Portfolio 1d (SJ TWA, new pipeline) Key Features and Costs

1d: SJ TWA (new pipeline) Highlights

24 mgd AWPF

Location: San José

Use: TWA (via a new dedicated pipeline to Piedmont Valve Yard)

Capital Cost: $605M*

Annual O&M Cost: $24.1M*

Levelized Unit Costs

- 30-Year Life Cycle: $2,600/AF*
- 100-Year Life Cycle: $2,200/AF*

Projected 2040 Yield:

- 24,000 AFY

Pipeline Length/Diameter

- 0.4 miles at 60”
- 8.2 miles at 36”
- 4.7 miles at 24”

BENEFITS

SJ/SC RWF flows do not limit projected yield. Northern parts of Santa Clara and San José could receive TWA to supplement water supply. For other water retailers, purified water would flow south through a new dedicated pipeline before blending with other treated supply and distributing via the Milpitas Pipeline (flowing north) and the East Pipeline. Existing infrastructure could support potential operational flexibility such as delivery to LGRP or Rinconada (with additional costs for improvements needed to connect existing systems), pending regulatory approval.

LIMITATIONS

A minimum flow guarantee for source water requires a long-term agreement with San José. Risks to available yield include drought, environmental needs/impacts, and operations. Further evaluation and coordination needed to confirm acceptability of purified water blending ratio.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy, based on the Evaluation of ROC Management Options Final Report. Unit costs reflect ROC management range as a single value due to rounding.*

Valley Water’s ROC Management Team (Valley Water staff and a consultant team led by GHD) separately evaluated ROC management strategies and documented the findings in a report dated September 1, 2020 entitled *Evaluation of ROC Management Options Final Report* (Valley Water, 2020a), which is attached to the CoRe Plan as *Appendix G.*

The AWPF considered for each San José portfolio is estimated to generate up to 4.3 mgd of ROC depending on the production of purified water. The ROC Management Options Final Report identified two options for managing ROC from a San José AWPF:

San José ROC Strategy, Option 1: Blending and discharge at a new outfall downstream of existing effluent outfall discharge weir. This option involves constructing a ROC pump station and holding tank, 1.8 miles of 18” HDPE pipe from the AWPF to a new outfall near the existing effluent weir, and an outfall diffuser at the discharge point. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

San José ROC Strategy, Option 2: Discharge at a new shallow outfall at Coyote Creek. This option involves constructing a ROC pump station and holding tank, 3.8 miles of 18” HDPE pipe from the AWPF to a new outfall at Coyote Creek, and an outfall diffuser at the discharge point. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

The ROC management report includes an analysis of various strategies at the San José AWPF without recommending a single option for implementation, thus allowing flexibility for continued discussions and negotiations among Valley Water, Partner Agencies, and Regional Boards. Capital and O&M costs shown in Tables 6-2 to 6-5 assume implementation of **ROC Option 1** for San José portfolios. Capital costs could increase (an addition of up to $10M) if implementing a higher cost strategy as evaluated in the final report of ROC management options.

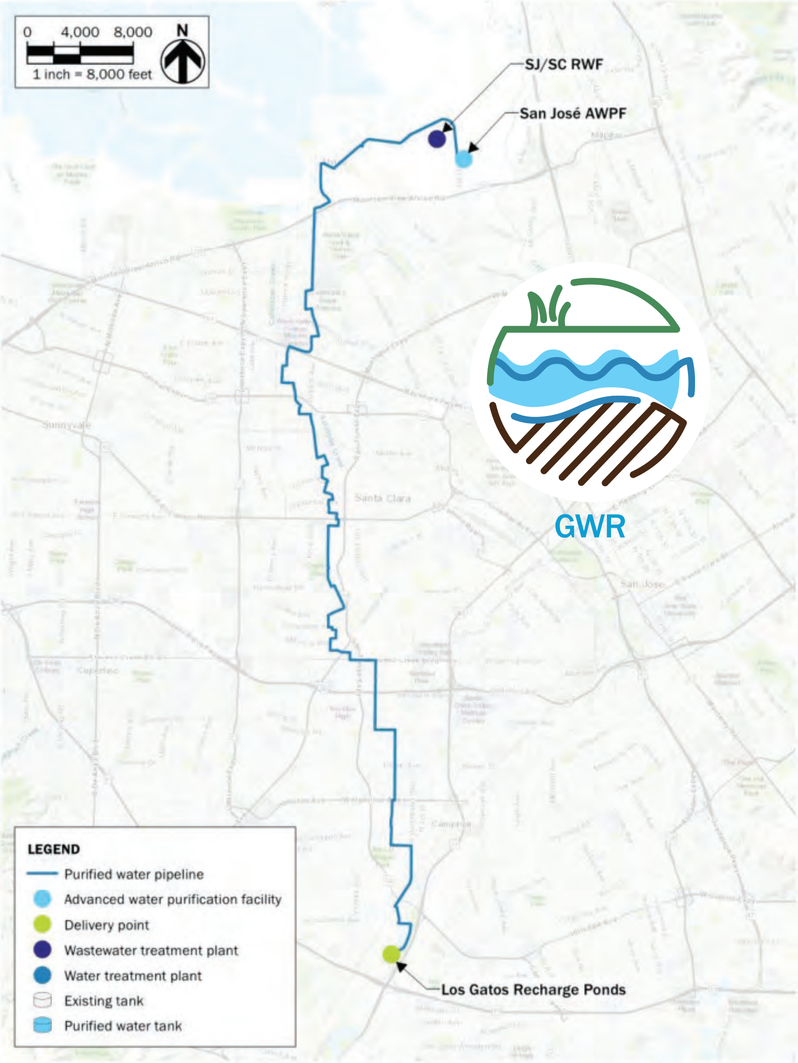


Figure 6-1. Portfolio 1a: SJ GWR facility locations and pipeline alignments

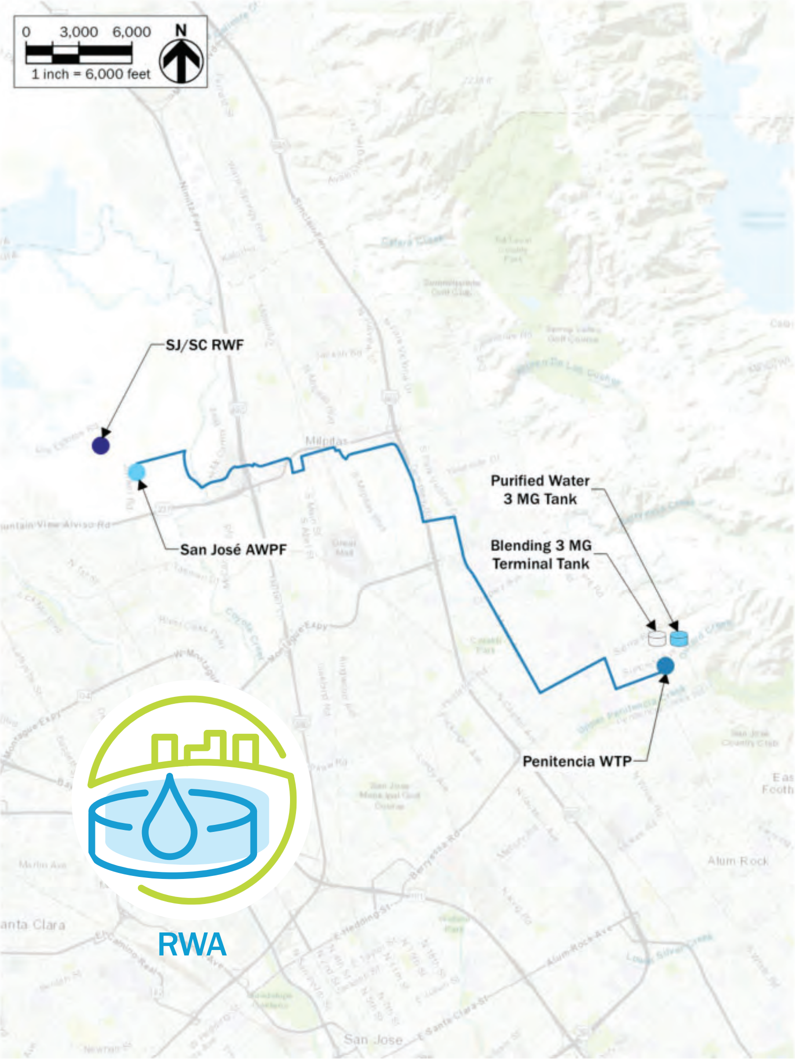


Figure 6-2. Portfolio 1b: SJ RWA facility locations and pipeline alignments

Note: The purified water pipeline alignment from the San José AWPF to Penitencia WTP may require special geotechnical considerations in the next phase of design. Class 5 cost estimates include large contingency factors.

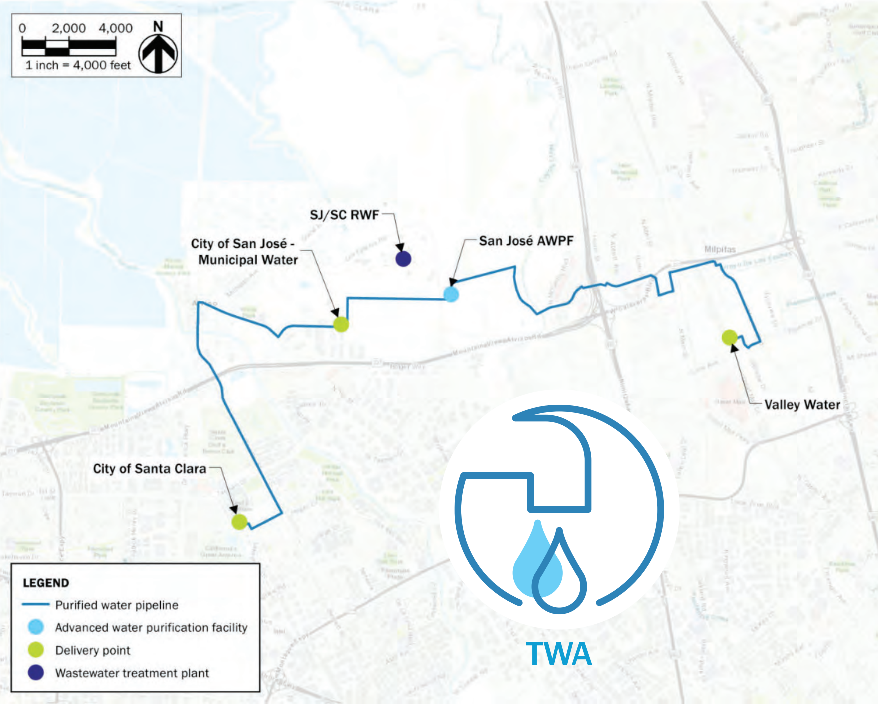


Figure 6-3. Portfolio 1c: SJ TWA (Milpitas pipeline) facility locations and pipeline alignments

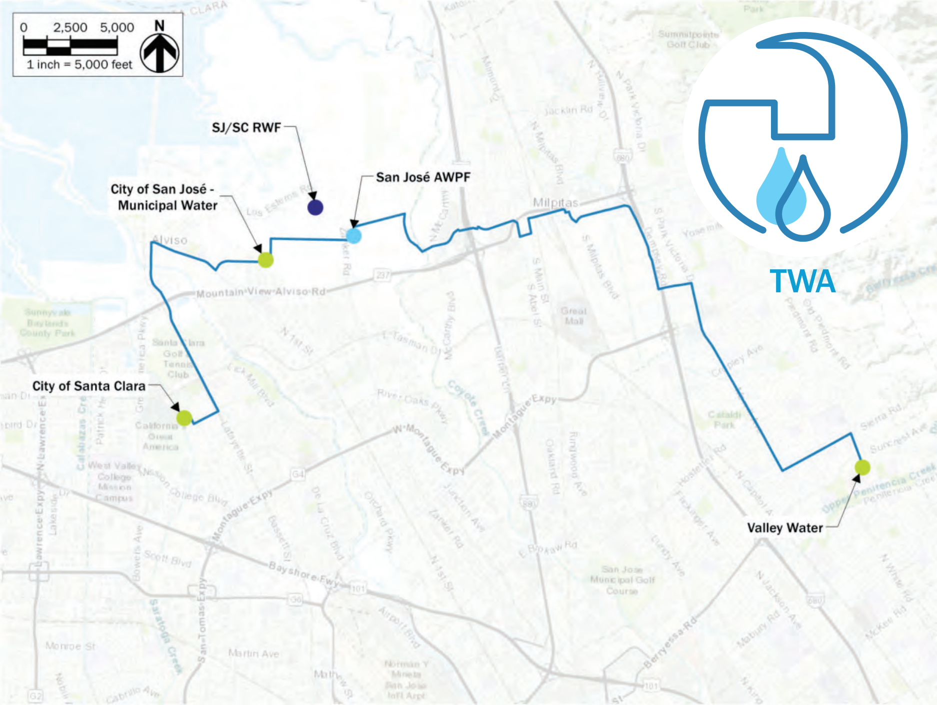


Figure 6-4. Portfolio 1d: SJ TWA (new pipeline) facility locations and pipeline alignments

Portfolios 1c and 1d explore using SJ/SC RWF source water for TWA, making Portfolio 1 an interesting and unique case study that reflects the full range of potable reuse options Valley Water is considering. Portfolios 1a (GWR) and 1b (RWA) are largely consistent with alternatives developed as part of the Purified Water Program Plan (Valley Water, 2018). Portfolios 1c and 1d represent an important first step toward testing whether TWA may yield significant costs savings compared to GWR and RWA. Insights from Portfolio 1 may help inform potential next steps related to the various TWA opportunities that exist throughout the County, as further described in Section 7.3.

6.2.2 Palo Alto and Sunnyvale Combined-Flow Regional AWPF for GWR

Two variations of Portfolio 2 consider combining available effluent from Palo Alto RWQCP and Sunnyvale WPCP for purification at one AWPF located in either Palo Alto or Sunnyvale (Portfolios 2a and 2b, respectively), providing regional benefit through GWR at LGRP. Sourcing one AWPF from two WWTPs under separate ownership and operations is not common and likely triggers unique interagency and regulatory requirements. Further, for portfolios that consider purifying effluent from Palo Alto and/or Sunnyvale WWTPs, source flow availability is a key consideration; even when combined from both sources, future WWTP influent flow may not meet Valley Water's 24,000 AFY PR goal. Portfolios 2a and 2b are each designed to deliver up to 23,000 AFY to LGRP for GWR. Key features and costs for the PA+SV GWR Portfolio variations are summarized in Tables 6-6 and 6-7, while Figures 6-5 and 6-6 show their respective facility locations and pipeline alignments.

Table 6-6. Portfolio 2a (PA [+SV] GWR) Key Features and Costs

2a: PA (+SV) GWR Highlights

24.5 mgd AWPF

Location: Palo Alto

Use: GWR at LGRP (24 mgd) and NPR+ in Sunnyvale (0.5 mgd)

Capital Cost: $800M*

Annual O&M Cost: $22.5M*

Levelized Unit Costs

- 30-Year Life Cycle: $3,000-$4,000/AF*
- 100-Year Life Cycle: $2,400-$3,100/AF*

Projected 2040 Yield: 17,000-23,000 AFY

Pipeline Length/Diameter

- 20.3 miles at 48"
- 10.3 miles at 36"

BENEFITS

Valley Water has a long-term agreement with Palo Alto to receive flows and is negotiating similarly with Sunnyvale.

LIMITATIONS

Palo Alto RWQCP and Sunnyvale WPCP flows limit projected yield. Permitting and regulatory compliance for ROC management need to be confirmed. Costs for acquiring AWPF site are not included.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy, based on the Evaluation of ROC Management Options Final Report. Unit costs reflect ROC management and potential 2040 yield ranges.*

Table 6-7. Portfolio 2b (SV [+PA] GWR) Key Features and Costs

2b: SV (+PA) GWR Highlights

24.5 mgd AWPF

Location: Sunnyvale

Use: GWR at LGRP (24 mgd) and NPR+ in Sunnyvale (0.5 mgd)

Capital Cost: $805M*

Annual O&M Cost: $21.6M*

Levelized Unit Costs

- 30-Year Life Cycle: $3,000-$3,900/AF*
- 100-Year Life Cycle: $2,400-$3,100/AF*

Projected 2040 Yield: 17,000-23,000 AFY

Pipeline Length/Diameter

- 17.1 miles at 48"
- 10 miles at 36"

BENEFITS

Valley Water has a long-term agreement with Palo Alto to receive flows and is in discussions with Sunnyvale.

LIMITATIONS

Palo Alto RWQCP and Sunnyvale WPCP flows limit projected yield. Technical feasibility and costs to prepare Recycle Hill (a former landfill site next to Sunnyvale WPCP) for AWPF construction remain in question. Due to lack of available land, Recycle Hill is the site assumed for preliminary design purposes; costs reflect best available for site preparation. In addition, ROC management options are limited and less feasible compared to other reuse opportunities and AWPF locations.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital, O&M, and unit costs assume the implementation of the ROC management strategy for an AWPF located in Sunnyvale as identified in the Evaluation of ROC Management Options Final Report. Unit costs reflect potential 2040 yield ranges.*

Both variations of Portfolio 2 (a regional AWPF purifying combined flow from Palo Alto RWQCP and Sunnyvale WPCP) are estimated to produce up to 4.3 mgd of ROC, regardless of the AWPF location.

The *Evaluation of ROC Management Options Final Report* prepared by GHD (Valley Water, 2020a) identified three options for managing ROC from a regional AWPF located in Palo Alto:

- **Palo Alto ROC Strategy, Option 1:** Blending and discharge at the existing RWQCP outfall. This option involves constructing a ROC pump station and holding tank and 2.1 miles of 18” HDPE pipe from the AWPF to the existing outfall. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- **Palo Alto ROC Strategy, Option 2:** Discharge at a new shallow outfall in San Francisco Bay. This option involves constructing a ROC pump station and holding tank, 2.8 miles of 18” HDPE pipe from the AWPF to the existing outfall, and 0.2 miles of 18inch HDPE pipe from the existing outfall to a location under San Francisco Bay. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.
- **Palo Alto ROC Strategy, Option 3:** Discharge at a deep-water outfall north of Dumbarton Bridge. This option involves constructing a ROC pump station and holding tank and 13.3 miles of 20” HDPE pipe from the AWPF to an existing deep-water outfall in Redwood City. Treatment processes for nutrients and CECs are also included in the ROC management cost estimate.

The ROC management report provides an analysis of various strategies at the Palo Alto AWPF without identifying a recommended option for implementation, thus allowing flexibility for continued discussions and negotiations among Valley Water, Partner Agencies, and Regional Boards. Capital and O&M costs shown in Table 6-6 assume implementation of **ROC Option 1** for the regional AWPF in Palo Alto. Capital costs could increase (by as much as $60M) if implementing a higher cost strategy as evaluated in the final report of ROC management options.

The *Evaluation of ROC Management Options Final Report* prepared by GHD (Valley Water, 2020a) identified a single option for managing ROC from a regional AWPF located in Sunnyvale:

- **Sunnyvale ROC Strategy:** Discharge at a new shallow outfall at Guadalupe Slough. Involves constructing a ROC pump station, holding tank, and 6.2 miles of 18” HDPE pipe from the AWPF to a new outfall discharge at Guadalupe Slough. ROC management cost estimate includes treatment processes for nutrients and CECs.

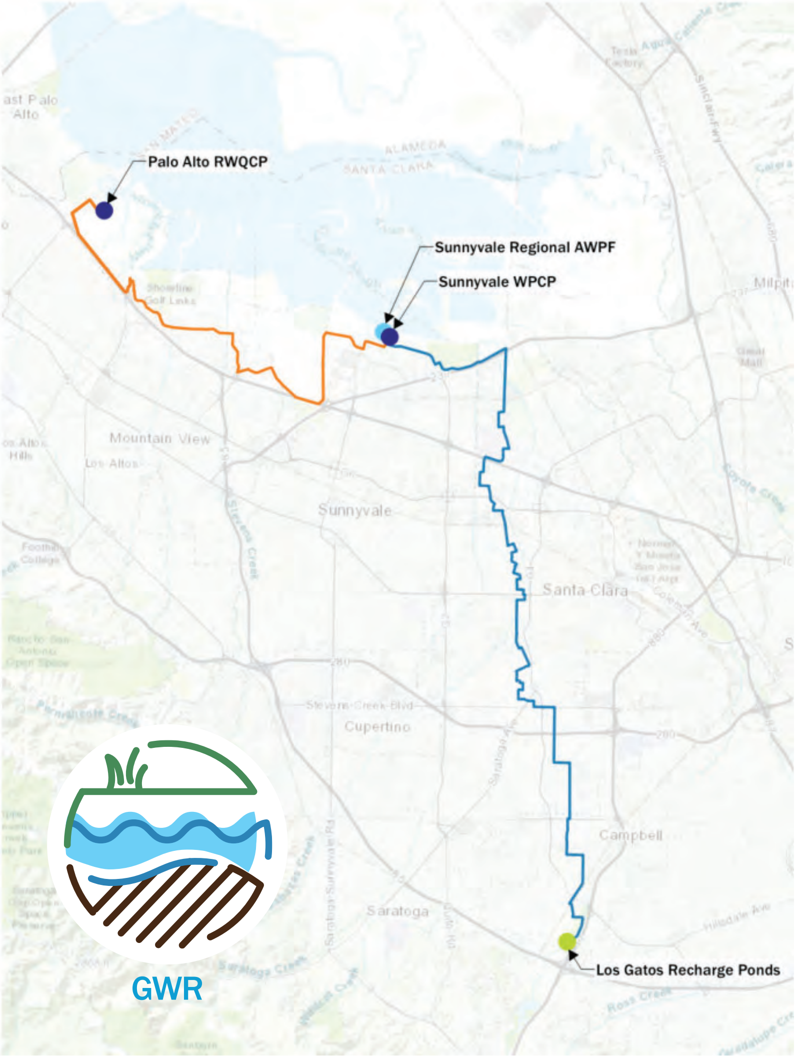


Figure 6-5. Portfolio 2a: PA (+SV) GWR facility locations and pipeline alignments

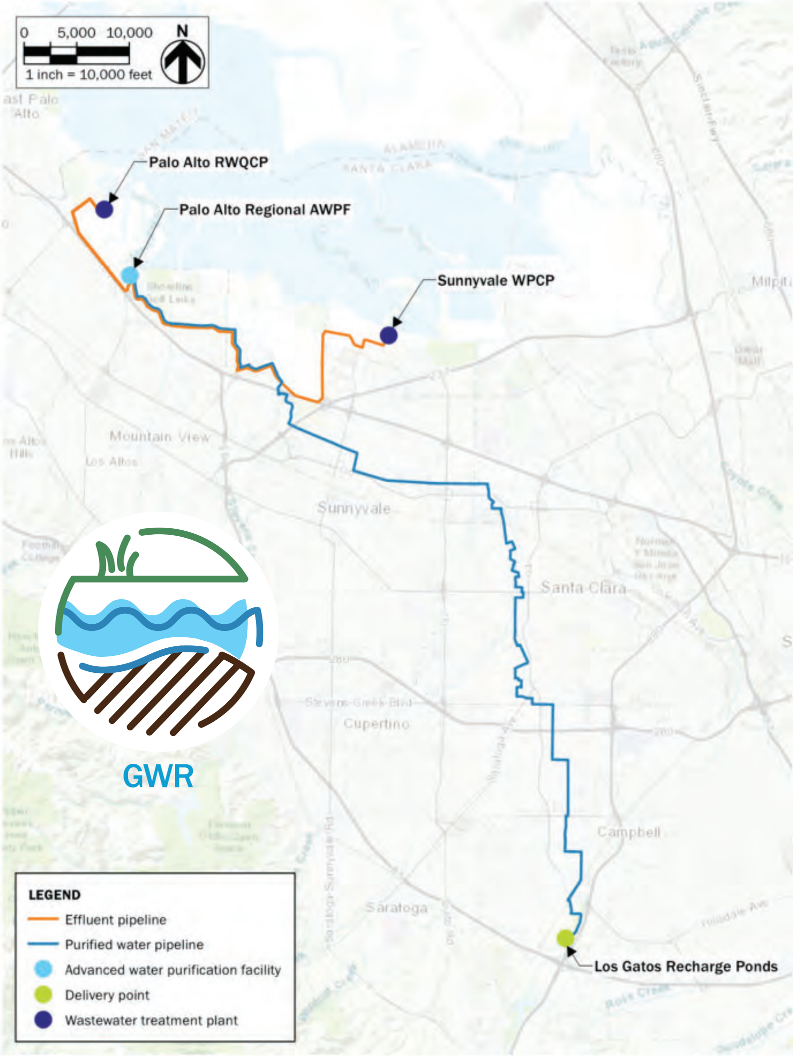


Figure 6-6. Portfolio 2b: SV (+PA) GWR facility locations and pipeline alignments

6.2.3 Palo Alto/Sunnyvale (PA/SV) Two Separate AWPFs for GWR

Portfolio 4 (PA/SV GWR) considers purifying available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP at two separate AWPFs and conveying to LGRP for GWR. The Palo Alto facility would be located on the former Los Altos Treatment Plant site located in Palo Alto; the Sunnyvale AWPF would be located on Recycle Hill. Key features and costs are summarized in Table 6-8, while Figure 6-7 shows respective facility locations and pipeline alignments.

Table 6-8. Portfolio 4 (PA/SV GWR) Key Features and Costs

4: PA/SV GWR Highlights:

2 AWPFs:
14 mgd in Palo Alto,
10.5 mgd in Sunnyvale

Use:
GWR at LGRP

Capital Cost: $850M*

Annual O&M Cost: $23.0M*

Levelized Unit Costs

- 30-Year Life Cycle: $3,200-$4,300/AF*
- 100-Year Life Cycle: $2,500-$3,300/AF*

Reuse Type & Delivery Point: GWR at LGRP

Projected 2040 Combined Yield: 17,000-23,000 AFY

Pipeline Length/Diameter

- 13.7 miles at 48”
- 11.6 miles at 36”

BENEFITS

Valley Water has a long-term agreement with Palo Alto. Having two AWPFs allows Valley Water to build one facility first and the other when needed.

LIMITATIONS

Palo Alto RWQCP and Sunnyvale WPCP flows limit projected yield. Constructing and operating two separate AWPFs is costly. Costs for acquiring the proposed AWPF site in Palo Alto are not included. Though Sunnyvale owns the proposed AWPF site (Recycle Hill), technical feasibility of the location remains uncertain and requires further geotechnical and geo-environmental studies. The best available estimate for site preparation cost is included. ROC management options are limited at Sunnyvale.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. Capital and O&M costs assume the implementation of the most cost-effective ROC management strategy at the Palo Alto AWPF, based on the Evaluation of ROC Management Options Final Report (Valley Water, 2020a). Unit costs reflect ROC management and potential 2040 yield ranges.*

Portfolio 4 (Palo Alto AWPF). The single-source water variation of an AWPF in Palo Alto would produce up to 2.5 mgd of ROC. The same three ROC management options identified in Portfolio 2a (a combined regional Palo Alto facility) also apply to this portfolio, though sizing is different due to smaller capacity of treating flow from the Palo Alto RWQCP. Key differences are summarized below.

- **Palo Alto ROC Strategy, Options 1 and 2:** Similar to ROC Options 1 and 2 for Portfolio 2a (one regional AWPF in Palo Alto, except a smaller 14” (vs. 18”) HDPE pipe from the AWPF to the existing outfall.
- **Palo Alto ROC Strategy, Option 3:** Similar to ROC Option 3 for Portfolio 2a, except a smaller 14” (vs. 20”) HDPE pipe from the AWPF to an existing deep-water outfall in Redwood City.

The *Evaluation of ROC Management Options Final Report* prepared by GHD (Valley Water, 2020a) provides an analysis of various strategies at the Palo Alto AWPF without recommending a single option for implementation, thus allowing flexibility for continued discussions and negotiations among Valley Water, Partner Agencies, and Regional Boards. Capital and O&M costs shown in Table 6-8 assume implementation of **ROC Option 1** for Portfolio 4 (PA/SV GWR). Capital costs could increase (an addition of up to $40M) if implementing a higher cost strategy as evaluated in the final report of ROC management options.

Portfolio 4 (Sunnyvale AWPF): The single-source water variation of an AWPF in Sunnyvale would produce up to 1.8 mgd of ROC. Similar to Portfolio 2b (a combined regional AWPF in Sunnyvale), only one ROC management option was identified this facility:

- **SUNNYVALE ROC STRATEGY:** Same as the ROC option for one regional AWPF in Sunnyvale, except a smaller 12” (vs. 18”) HDPE pipe from the AWPF to a new outfall discharge point at Guadalupe Slough.

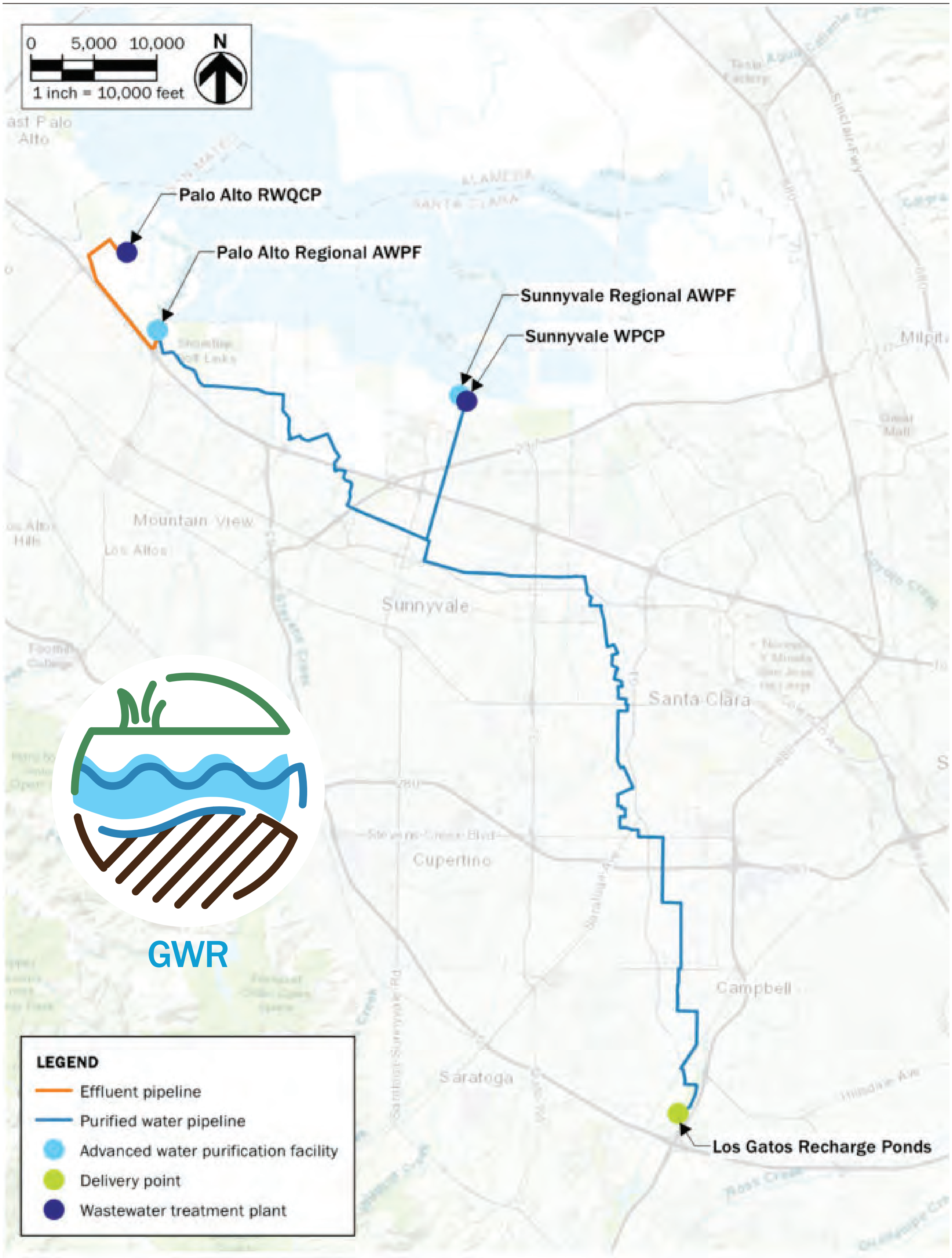


Figure 6-7. Portfolio 4: PA/SV GWR facility locations and pipeline alignments

6.3 South County Reuse Options

To explore solutions for augmenting water supply in South County, the Project Team reviewed previous reuse studies and plans before developing new conceptual alternatives for consideration. Though the 2015 South County Recycled Water Master Plan (RWMP) (SCRWA, 2016) evaluated reuse alternatives in both Gilroy and Morgan Hill, the recommendations focused on expanding NPR distribution in Gilroy, since the substantial energy and infrastructure required to convey recycled water north from the SCRWA WWTP to Morgan Hill would be less cost-effective. Recycled water service at the SCRWA facility is already challenged in meeting existing maximum day NPR demand in Gilroy (5.2 mgd in 2014), using most of the average dry weather influent flow (6.0 mgd in 2014); storage and pumping are needed to manage daily and diurnal variations in flow to meet NPR demand.

SCRWA, Morgan Hill, Gilroy, Valley Water, and the Project Team met (in person and via phone) to explore South County reuse project concepts and collaboratively developed a list of potential opportunities, as summarized in Table 6-9. From this list, SCRWA, Morgan Hill, and Gilroy staff agreed to focus the CoRe Plan efforts for South County on improving overall water supply reliability in Morgan Hill and selected three opportunities, referred to as Morgan Hill (MH) Options 1 (MH-1: NPR+), 2 (MH-2: GWR), and 3 (MH-3: SWA).

Table 6-9. Potential Future South County Reuse Opportunities

Reuse Type	Source Flow	Delivery Point	Summary	Capital Cost ($2019)
NPR	SCRWA	New Morgan Hill NPR distribution system	Per the 2015 South County RWMP, extend pipeline parallel to existing joint sewer trunk line to convey recycled water from SCRWA in Gilroy to Morgan Hill	$60M [a]
NPR+	SBWR	New Morgan Hill NPR distribution system	Extend Silver Creek Pipeline from Metcalf Energy Center to customers in Morgan Hill; includes a 6-mile pipeline extension and serving peak demands up to 5 mgd for an estimated annualized NPR demand of 2,900 AFY **Referred to as Morgan Hill OPTION 1 (MH-1: NPR+)**	$70M [b]
GWR	Morgan Hill satellite WWTP and AWPF	San Pedro Ponds (assumed location for design and costs)	Recharge Llagas Subbasin using purified water from a satellite WWTP and AWPF in Morgan Hill (flow diverted from the SCRWA trunk line) **Referred to as Morgan Hill OPTION 2 (MH-2: GWR)**	$125M [b]
SWA	Morgan Hill satellite WWTP and AWPF	Anderson Reservoir	Augment Anderson Reservoir using purified water from a satellite WWTP and AWPF in Morgan Hill, pumping to the reservoir for blending and dilution, and subsequent treating at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit **Referred to as Morgan Hill OPTION 3 (MH-3: SWA)**	$145M [b]
SWA	SCRWA and Gilroy AWPF	Coyote Reservoir	Augment Coyote Reservoir using purified water from an AWPF at SCRWA (Gilroy), pumping to the reservoir for blending and dilution, and subsequent treating at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit	-- [c]
RWA	SCRWA and Gilroy AWPF	Pacheco Conduit	Pump purified water from an AWPF at SCRWA (Gilroy) to Pacheco Conduit for RWA at Santa Teresa and/or Rinconada WTPs. In exchange, Valley Water would recharge Llagas Subbasin with equal volume of raw water from Santa Clara Conduit	-- [c]
TWA	Morgan Hill satellite WWTP and AWPF	Morgan Hill potable distribution system	Deliver purified water from a satellite WWTP and AWPF in Morgan Hill to engineered storage, then into Morgan Hill's potable water distribution system	-- [c]
TWA	SCRWA and Gilroy AWPF	Gilroy potable distribution system	Deliver purified water from an AWPF at SCRWA to engineered storage, then into Gilroy's potable water distribution system	-- [c]

[a] *Costs from SCRWA (2016) escalated to 2019 dollars.*
[b] *See Appendix A-6: Cost Estimates for cost details.*
[c] *Not available*

Morgan Hill reuse options were developed to the same level of detail as North County portfolios, including preliminary designs and AACE Class 5 cost estimates, as summarized in Tables 6-10 to 6-12. Valley Water's ROC Management Project Team reported the only option available for managing ROC from a Morgan Hill or Gilroy-based AWPF is construction of lined evaporation ponds of about 80 to 100 acres in size at a location not yet identified but assumed to be near the SCRWA WWTP for the purpose of preliminary design and costs.

Table 6-10. MH-1 (NPR+) Key Features and Costs

MH-1: NPR+ Highlights:

6-mile Silver Creek Pipeline extension (at 16", 5 mgd capacity)

Location: SBWR system connection (to north) and new recycled water system in Morgan Hill (to south)

Use: NPR+

Capital Cost: $70M*

Annual O&M Cost: $2.6M*

Levelized Unit Costs

- 30-Year Life Cycle: $2,200/AF*
- 100-Year Life Cycle: $1,700/AF*

Projected 2040 Yield: 2,900 AFY

Conveyance Pipeline: 6 miles at 16"

Distribution Pipelines: 16.4 miles at various diameters

BENEFITS

MH1: NPR+ improves water supply reliability for Morgan Hill by importing NPR+ supply from SBWR to serve non-potable demands in lieu of groundwater, which is currently Morgan Hill's sole source. MH-1 (NPR+) could be combined with MH-2 (GWR), MH-3 (SWA), or Portfolios 2 or 4 (PA/SV GWR).

LIMITATIONS

An agreement to establish terms of exporting SBWR NPR+ supply from San José and neighboring areas to Morgan Hill would be needed, as the existing Silver Creek Agreement between Valley Water and San José expires in 2027. Long-term supply reliability is unconfirmed. Operational impacts to the SBWR system have not been evaluated, and a new reservoir may be needed to supply reliable summertime flows. Further evaluation is needed to confirm feasibility of implementing MH-1 (NPR+) and variations of Portfolio 1 (San José AWPF), as they rely on the same source. Valley Water may need to revisit and update the Salt and Nutrient Management Plan to reassess potential impacts of recycled water on the Llagas Subbasin prior to moving forward.

Given shifting development trends in Morgan Hill, an update NPR market assessment is needed.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. The estimated cost of a new recycled water distribution system for Morgan Hill is included.*

Table 6-11. MH-2 (GWR) Key Features and Costs

MH-2: GWR Highlights:

2.5 mgd satellite WWTP and 2.1 mgd AWPF

Location: Morgan Hill

Use: GWR

(delivery point to be confirmed; San Pedro Ponds assumed for preliminary design)

Capital Cost: $125M*

Annual O&M Cost: $6.9M*

Levelized Unit Costs

- 30-Year Life Cycle: $7,200/AF*
- 100-Year Life Cycle: $6,100/AF*

Projected 2040 Yield: 1,900 AFY

- **Conveyance Pipeline:** 2.8 miles at 16"

BENEFITS

MH-2: GWR would improve water supply reliability and drought resilience for Morgan Hill by recharging the Llagas Subbasin with purified water. MH-2 (GWR) could be combined with MH-1 (NPR+) or Portfolios 1 (SJ GWR, RWA, or TWA), 2 (PA+SV GWR), or 4 (PA/SV GWR).

LIMITATIONS

High unit costs with uncertain value to improving South County water supply reliability. Limited wastewater available for satellite treatment in Morgan Hill and relied upon for meeting existing South County RWS demands. Morgan Hill satellite facility would increase solids loads to SCRWA, posing operational issues that may be substantial. If implemented in Morgan Hill, solids handling requires further study and may increase costs significantly. Density and proximity of active private wells limit GWR locations in South County. San Pedro Ponds is assumed delivery point; further evaluation needed to confirm viability. Conditions and reliability of increasing raw water delivery to Llagas Subbasin and specific recharge facility need to be confirmed. Evaporation pond for ROC management may face permitting challenges; also, assumed location in Gilroy gets inundated with stormwater (unsuitable for evaporation pond). MH-2 (GWR) and MH-3 (SWA) are mutually exclusive, as they rely on the same supply source.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. All costs shown here assume the implementation of the sole ROC management strategy identified for a Morgan Hill AWPF in the Evaluation of ROC Management Options Final Report prepared by GHD (Valley Water, 2020a).*

Table 6-12. MH-3 (SWA) Key Features and Costs

MH-3: SWA Highlights:

2.5 mgd satellite WWTP and 2.1 mgd AWPF

Location: Morgan Hill

Use: SWA at Anderson Reservoir

Capital Cost: $145M*

Annual O&M Cost: $7.2M*

Levelized Unit Costs

- 30-Year Life Cycle: $8,000/AF*
- 100-Year Life Cycle: $6,600/AF*

Projected 2040 Yield: 1,900 AFY

Conveyance Pipeline: 5.6 miles at 16”

BENEFITS

This option would improve water supply reliability and drought resilience for Morgan Hill by recharging the Llagas Subbasin with raw water supplied from Valley Water via the Santa Clara Conduit in exchange for an equivalent amount of purified water delivered to Anderson Reservoir for SWA. MH-3 (SWA) could be combined with either MH-1 (NPR+) or Portfolios 1 (SJ GWR, RWA, or TWA), 2 (PA+SV GWR), or 4 (PA/SV GWR).

LIMITATIONS

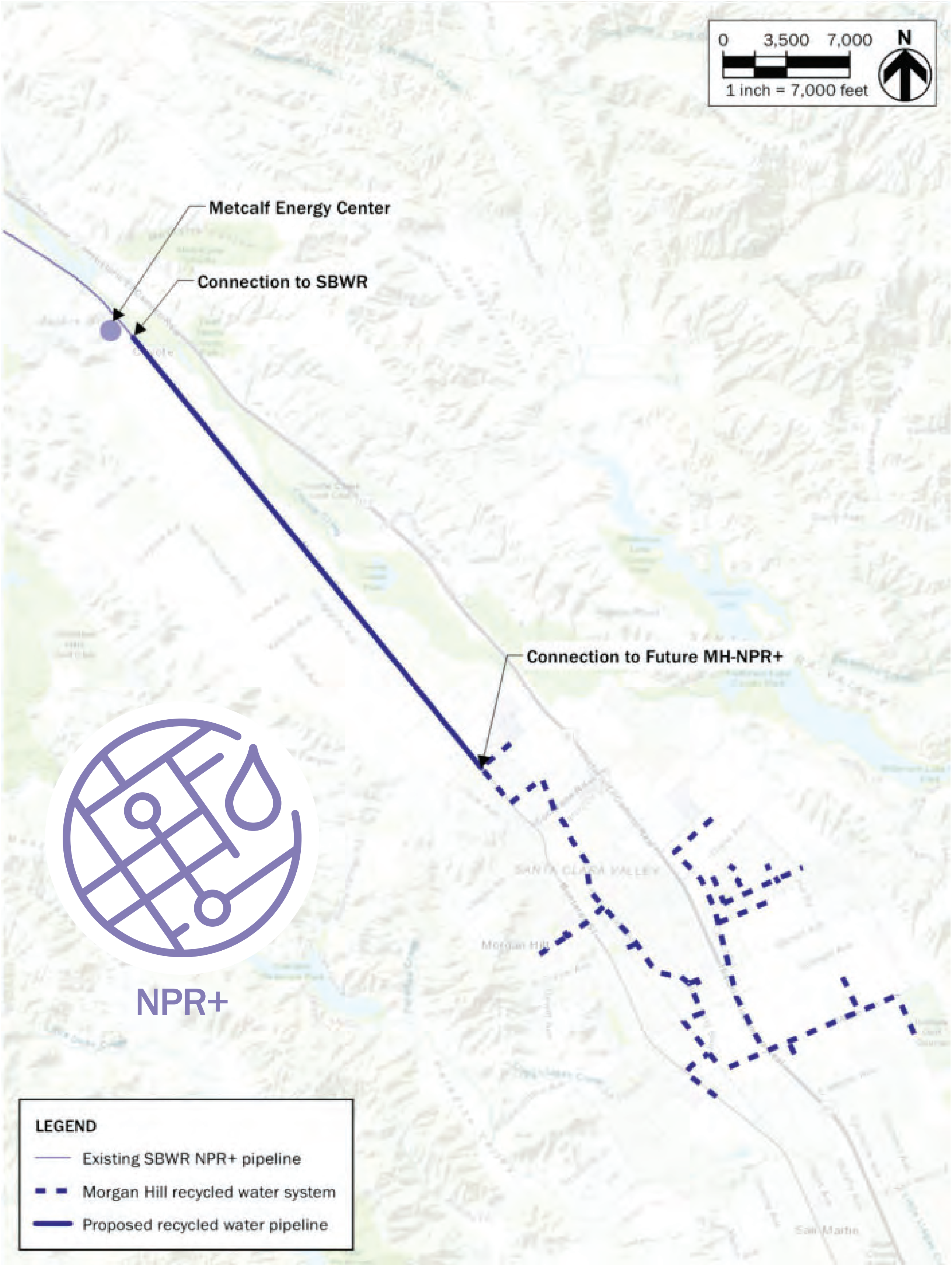
High unit costs with uncertain value to improving South County water supply reliability. Limited wastewater available for satellite treatment in Morgan Hill and relied upon for meeting existing South County RWS demands. Morgan Hill satellite facility would increase solids loads to SCRWA, posing operational issues that may be substantial. If implemented in Morgan Hill, solids handling requires further study and may increase costs significantly. New permits from Regional Board(s) and/or DDW needed for discharging purified water to Anderson Reservoir. Conditions and reliability of increasing raw water delivery to Llagas Subbasin and specific recharge facility need to be confirmed. Evaporation pond for ROC management may face permitting challenges; also, assumed location in Gilroy gets inundated with stormwater (unsuitable for evaporation pond). MH-2 (GWR) and MH-3 (SWA) are mutually exclusive, as they rely on the same supply source.

**Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs. All costs shown here assume the implementation of the sole ROC management strategy identified for a Morgan Hill AWPF in the Evaluation of ROC Management Options Final Report prepared by GHD (Valley Water, 2020a).*

The Morgan Hill satellite AWPF is estimated to produce up to 0.4 mgd of ROC. The *Evaluation of ROC Management Options Final Report* prepared by GHD (Valley Water, 2020a) identified one option for managing ROC from this facility:

- **Morgan Hill ROC Strategy:** Discharge to a lined evaporation pond of about 80 to 100 acres. Due to the area of land required for this approach and lack of adequately sized plots in Morgan Hill, Valley Water’s ROC Management Team assumed this approach would require pumping ROC and conveying through 11.1 miles of HDPE pipeline at 8” diameter to a SCRWA-owned plot of land near the WWTP in Gilroy.

Though the CoRe Plan uses this ROC management approach for the preliminary design and cost estimate related to a potential Morgan Hill satellite AWPF, the viability of the assumed location for the evaporation pond remains in question.


0
3,500
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1 inch = 7,000 feet
Metcalf Energy Center
Connection to SBWR
Connection to Future MH-NPR+
SANTA CLARA VALLEY
Morgan Hill
San Martin
NPR+
LEGEND
Existing SBWR NPR+ pipeline
Morgan Hill recycled water system
Proposed recycled water pipeline

Figure 6-8. MH-1 (NPR+) facility locations and pipeline alignments

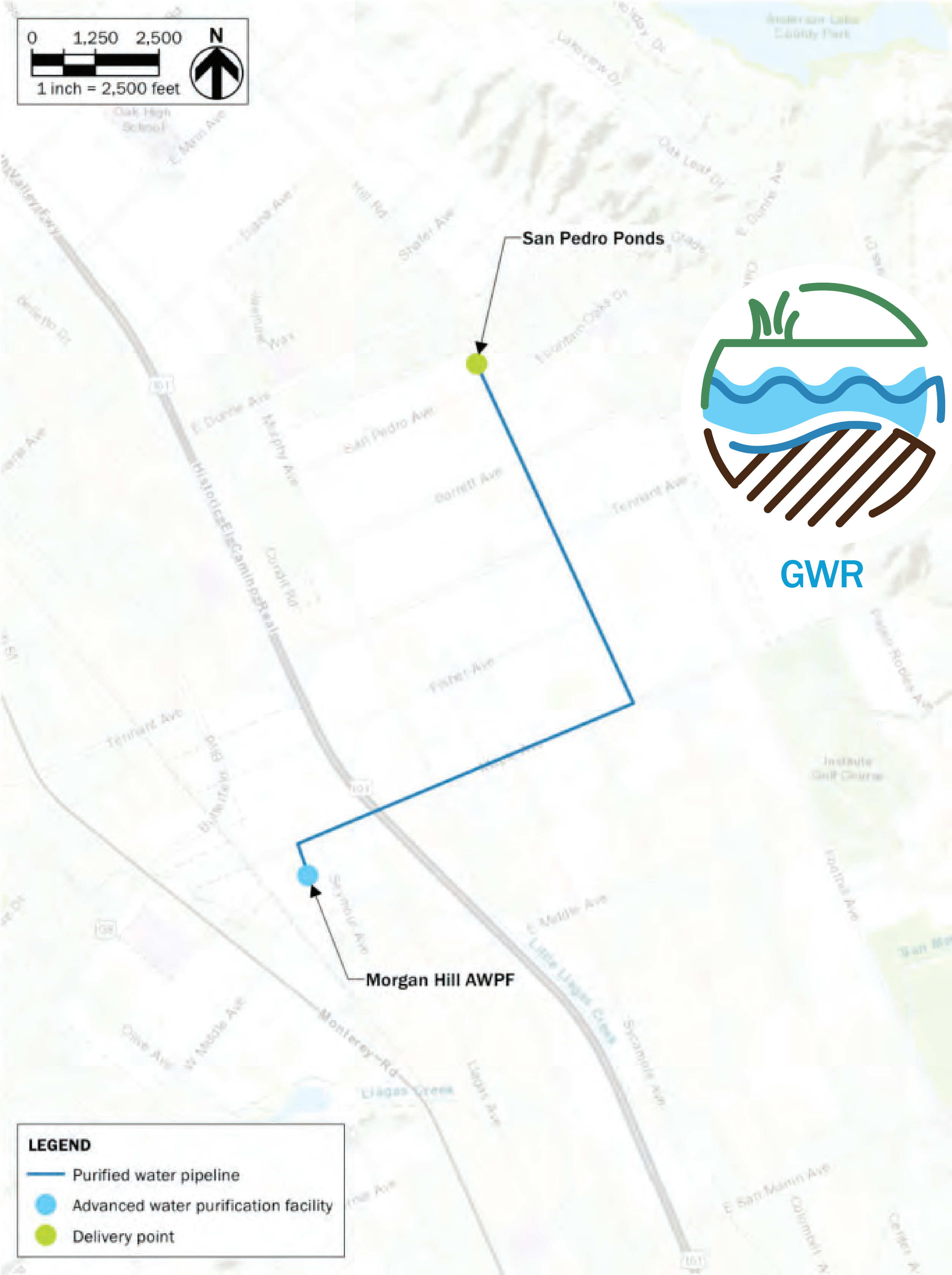

Figure 6-9. MH-2 (GWR) facility locations and pipeline alignments

Note: The San Pedro Ponds delivery point is assumed for preliminary design; further evaluation is needed to determine feasibility.

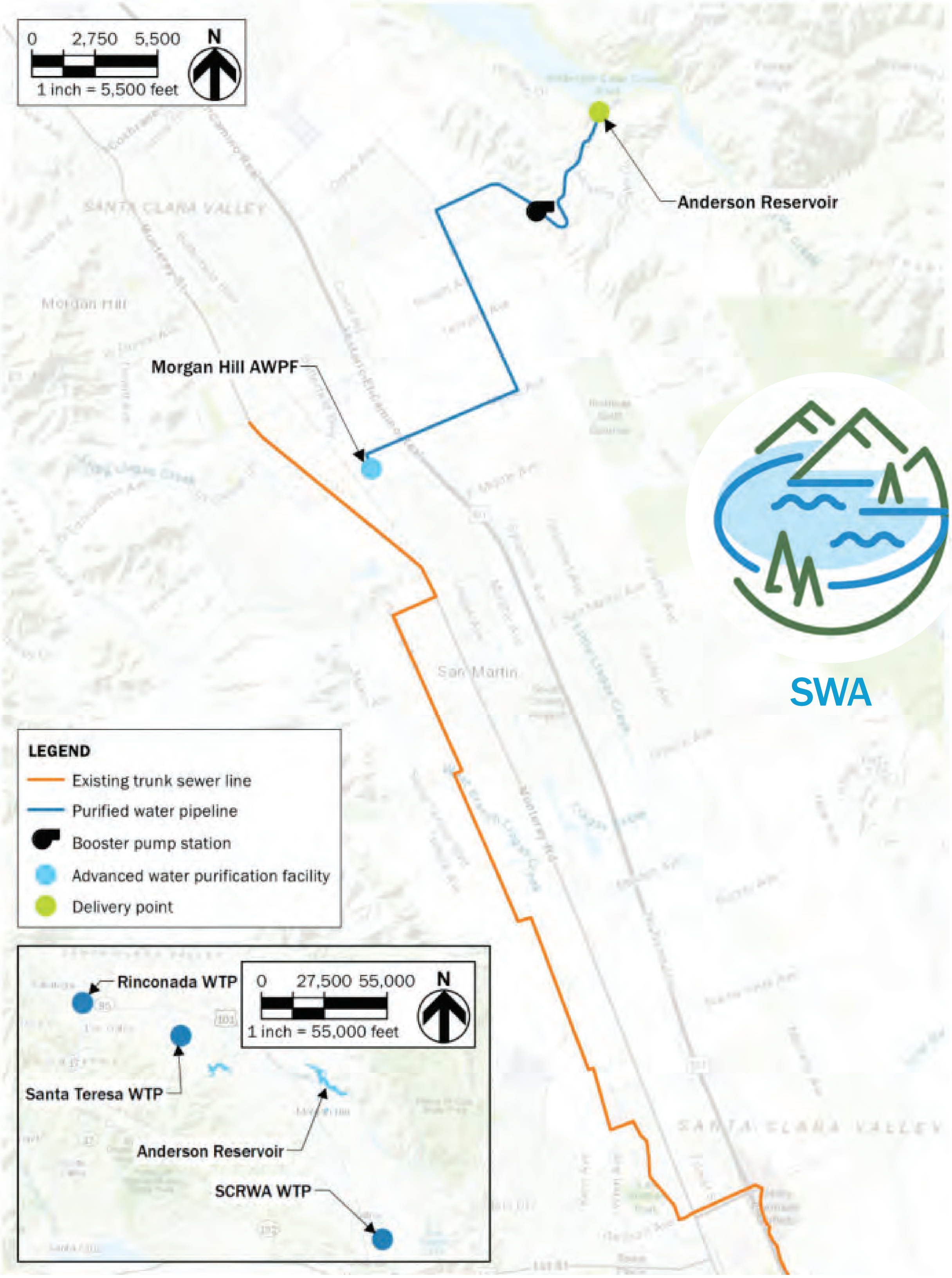

Figure 6-10. MH-3 (SWA) facility locations and pipeline alignments

6.4 At-a-Glance Comparison of Portfolios/Options and Cost Estimates

To compare North County portfolios and South County options, Figures 6-11 to 6-13 visually depict the range of estimated costs in terms of capital, operations and maintenance (O&M), and unit costs (levelized for annual yield and based on 30-year and 100-year life cycles), and Table 6-13 summarizes the estimated values. Cost ranges reflect the following factors.

1. **Source water availability,** which influences the design capacity (production) and efficiency of an AWPF and annual yield of purified water for potable reuse (the latter affects unit costs)
2. **ROC management strategies** for an AWPF in San José or Palo Alto (where Valley Water's ROC Management Team identified multiple options)
3. **Level of accuracy** for planning-level, AACE Class 5 cost estimates (from -50% to +100%)

As summarized further in Sections 7 and 8 and described with greater detail in ***Appendix A***, many opportunities exist for flexibility in implementing some of the projects described and evaluated within this CoRe Plan, such as:

- Phase implementation (such as flexible implementation scenarios in Section 9)
- Repackage projects, blending aspects of the portfolios with one another; add or remove some project element(s)
- Select an alternative alignment
- Optimize (or "right-size") design capacity of treatment facilities and conveyance infrastructure to reflect Board directives and current status of driving forces, such as: near-term policy updates changing Valley Water's potable reuse goals (production or yield); updated demand projections; or partner agreements

Implementing these opportunities could affect costs, with some actions resulting in cost increases and others resulting in cost reductions. Further, estimated costs do not consider impacts of external funding and, thus, do not necessarily represent the costs to Valley Water. As a result, comparison of unit costs as included in this CoRe Plan to others (different supplies, projects, or programs) may be misleading at this stage.

When comparing the planning-level estimated costs across the CoRe Plan portfolios/options, several observed trends lead to the following conclusions.

North County

- For similar production capacities, **capital costs** are estimated to be **lower for DPR versus GWR** (Figure 6-11).
- All four variations of Portfolio 1 (San José AWPF) are estimated at lower capital costs than Portfolios 2 and 4 (Palo Alto and/or Sunnyvale AWPFs).
- Of the four Portfolio 1 (San José AWPF) variations, estimated capital costs are lowest for TWA options (Portfolios 1c and 1d; RWA and GWR are similar, though RWA appears less costly in comparison.
- Both variations of Portfolio 2 (combined Palo Alto/Sunnyvale regional AWPF) have lower estimated capital costs compared to two separate AWPFs in Palo Alto and Sunnyvale (Portfolio 4).
- **Annual O&M costs** are estimated to be **lower for GWR versus DPR** (Figure 6-12).

South County

- For Morgan Hill options, estimated costs are **lowest for MH-1: NPR+** and **similar between MH-2: GWR and MH-3: SWA**. Levelized **unit costs** for **MH-2: GWR and MH-3: SWA** are about **twice as high** as potable reuse unit costs in North County (Figure 6-13).

Estimated Ranges of **Capital Costs**

Consistent with AACE International Class 5 level of project definition, the cost estimating accuracy ranges from -50% to +100%, as shown in Figure 6-11 for capital costs.

Any modifications or optimizations of these estimated life-cycle costs can either increase or reduce costs. Therefore, these cost estimates are susceptible to change.

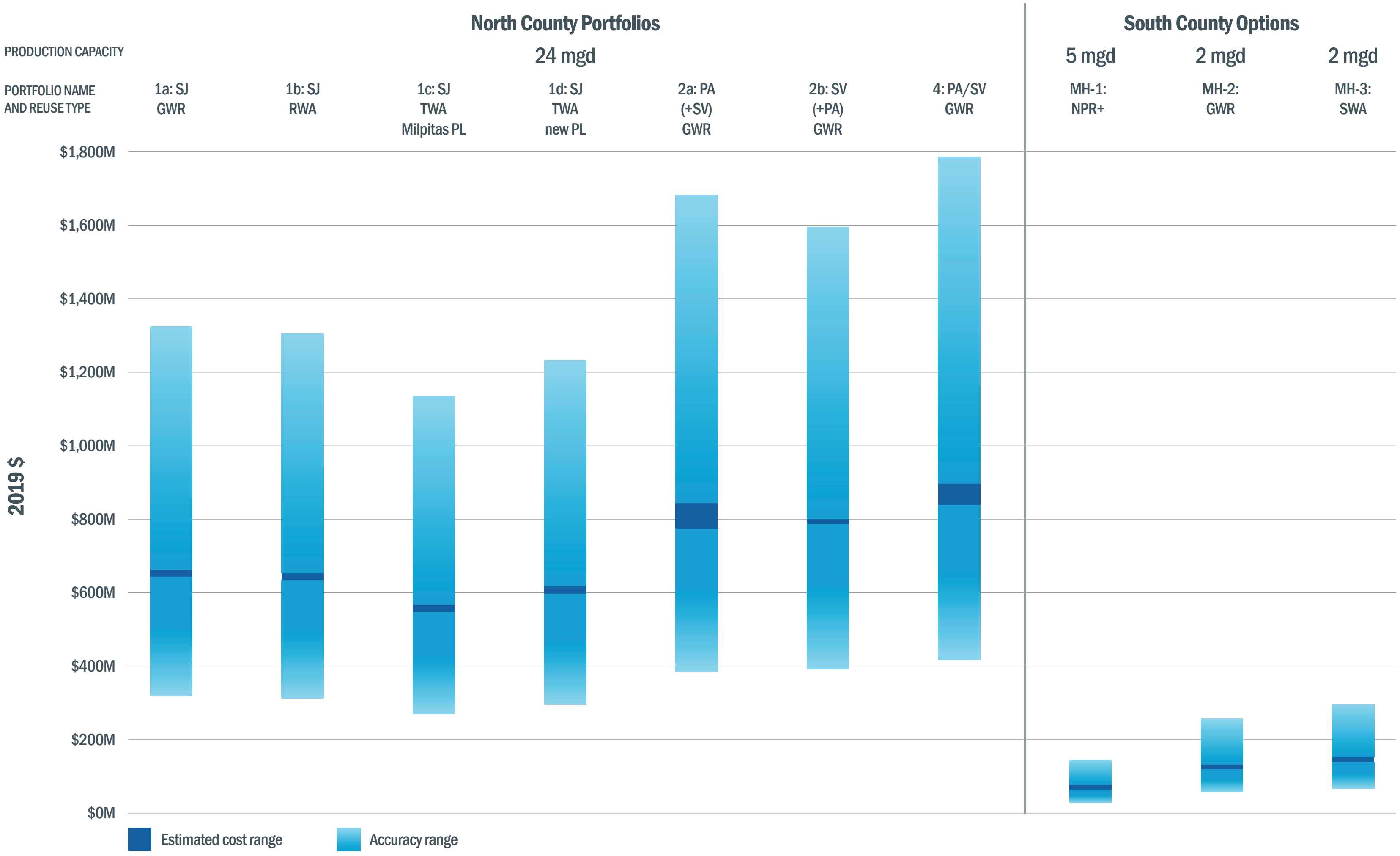

Figure 6-11. Ranges of estimated capital costs with AACE Class 5 level of accuracy

Notes: 1. As presented, capital costs do not reflect potential external funding and are not necessarily the costs to Valley Water.
2. Cost estimates reflect AACE International Class 5 criteria. Class 5 estimates have an expected accuracy range of -50% to +100%.

Attachment 2
Page 69 of 122

Estimated Ranges of **Annual O&M Costs**

Consistent with AACE International Class 5 level of project definition, the cost estimating accuracy ranges from -50% to +100%, as shown in Figure 6-12 for O&M costs.

Any modifications or optimizations of these estimated life-cycle costs can either increase or reduce costs. Therefore, these cost estimates are susceptible to change.

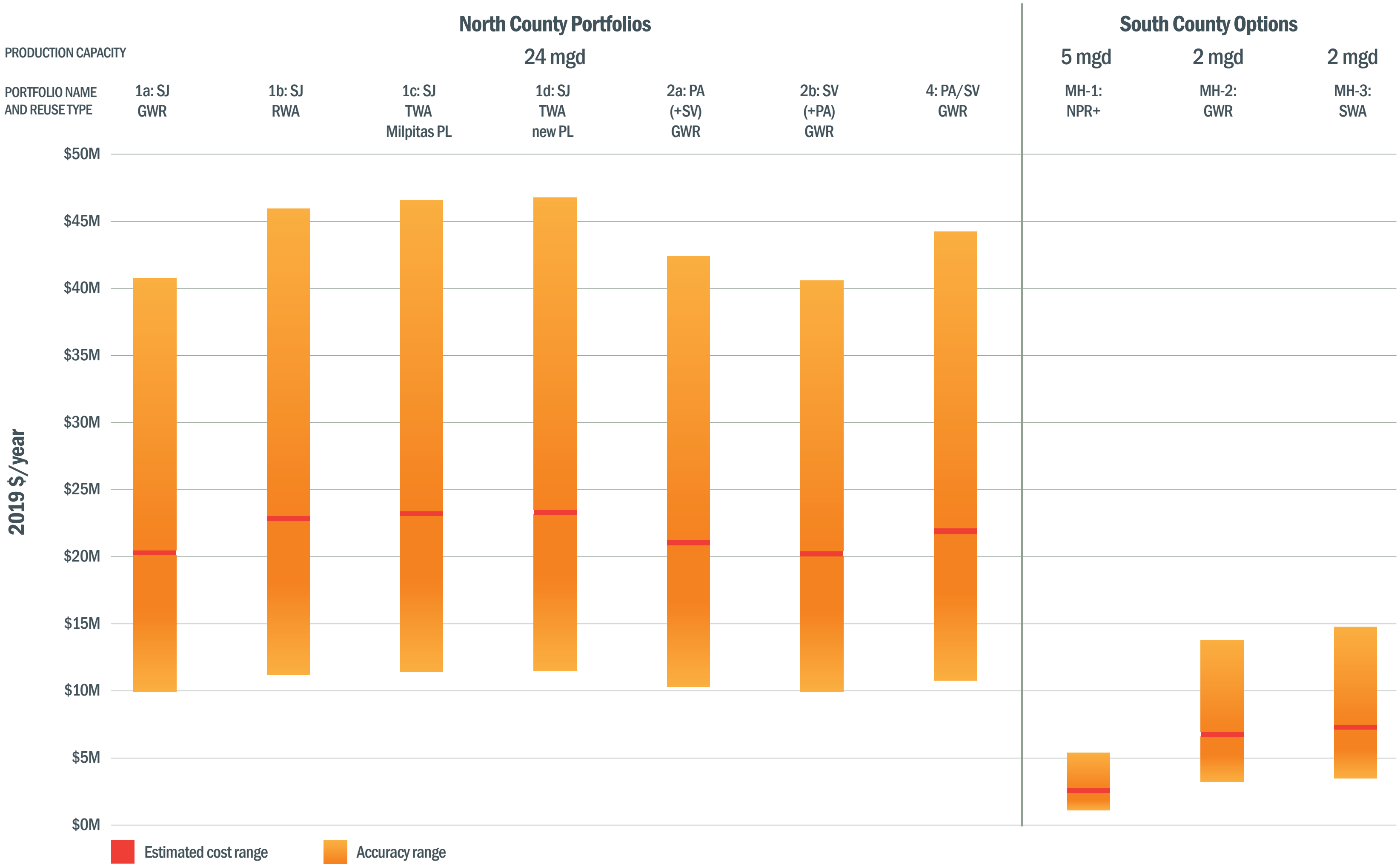

Figure 6-12. Ranges of estimated annual O&M costs with AACE Class 5 level of accuracy

Notes: 1. As presented, O&M costs do not reflect potential external funding and are not necessarily the costs to Valley Water.
2. Cost estimates reflect AACE International Class 5 criteria. Class 5 estimates have an expected accuracy range of -50% to +100%.

Estimated Ranges of **Unit Costs**

Consistent with AACE International Class 5 level of project definition, the cost estimating accuracy ranges from -50% to +100%, as shown in Figure 6-13 for 30-year and 100-year life cycles.

Any modifications or optimizations of these estimated life-cycle costs can either increase or reduce costs. Therefore, these cost estimates are susceptible to change.

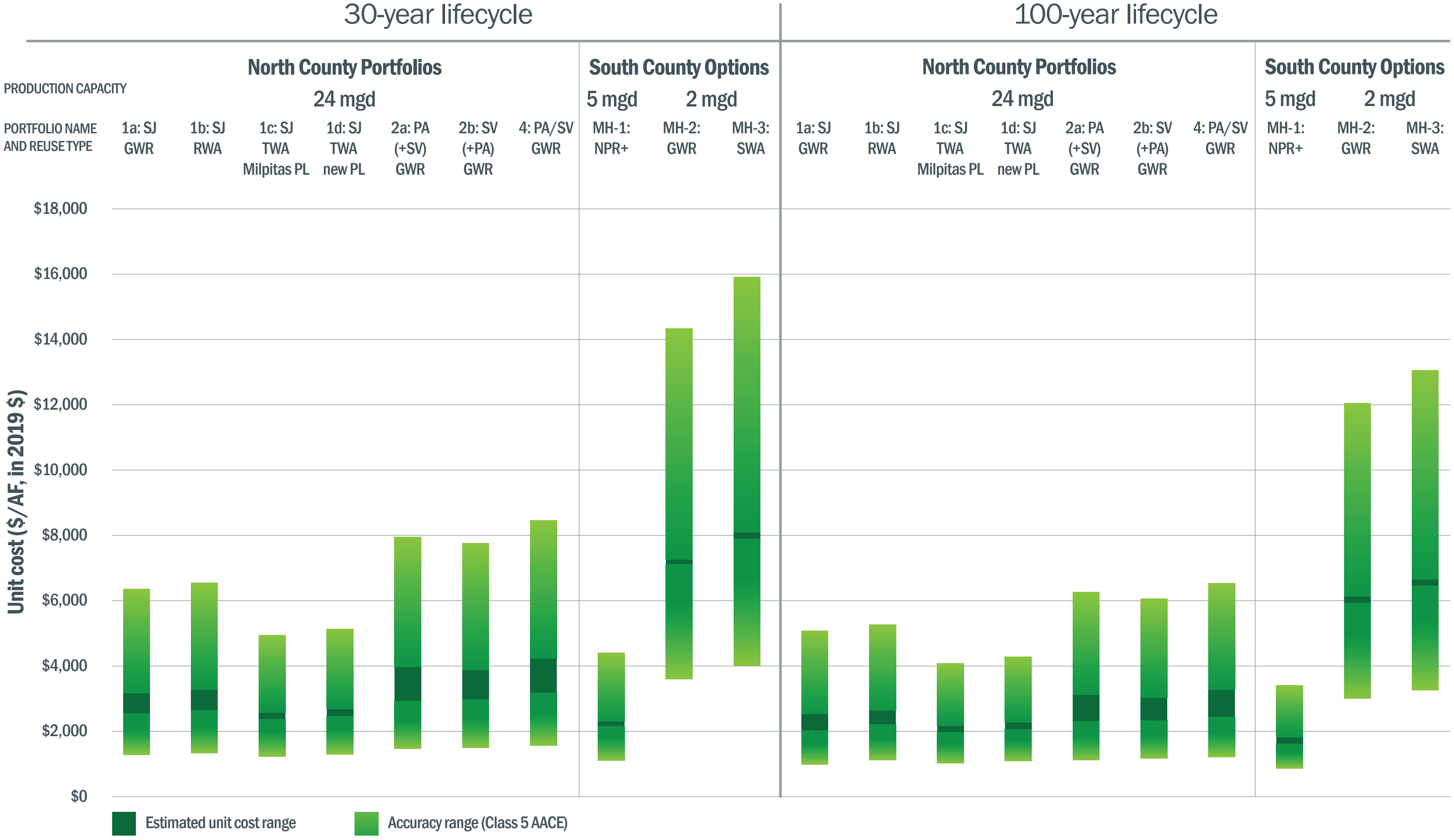

Figure 6-13. Levelized unit costs with AACE Class 5 level of accuracy (30-year and 100-year life cycles)

Notes: 1. Unit costs as presented do not consider potential external funding and are not necessarily the costs to Valley Water. Thus, comparison of these unit costs to other supplies may be misleading at this stage.
2. Cost estimates reflect AACE International Class 5 criteria. Class 5 estimates have an expected accuracy range of -50% to +100%.

Table 6-13. Estimated Portfolio Costs and ROC Management Options

Portfolio			ROC Management Strategy (*Option used to estimate capital and O&M costs)		Estimated Cost ($M) [a]		Levelized Unit Cost [a] ($/AF)	
					Capital	Annual O&M	30-year Life Cycle	100-year Life Cycle
Portfolio 1 Purifies effluent from SJ/SC RWF at a 24-mgd AWPF located in San José	**1a: SJ GWR**	Delivers 19,000-24,000 AFY to LGRP for GWR	**Option 1*** **Option 2**	ROC with residual final effluent and discharge at a new outfall downstream of existing effluent outfall discharge weir though an outfall diffuser Discharge at a new shallow outfall at Coyote Creek through an outfall diffuser	$655	$21.4	$2,600-$3,200	$2,100-$2,600
	1b: SJ RWA	Delivers 19,800-24,000 AFY to the SBA terminal tank upstream of Penitencia WTP for RWA			$650	$24.5	$2,700-$3,300	$2,300-$2,700
	1c: SJ TWA, Milpitas Pipeline	Delivers 24,000 AFY total for TWA, including: up to 4 mgd directly to Santa Clara and San José (north of Highway 101), and up to 20 mgd to Valley Water's retailers Serves purified water to several turnouts as the water flows south through the existing Milpitas Pipeline before reaching Piedmont Valve Yard (i.e., blending location near Penitencia WTP) and delivery via East Pipeline			$555	$24.1	$2,500	$2,100
	1d: SJ TWA, new pipeline	Delivers 24,000 AFY total for TWA, including: up to 4 mgd directly to Santa Clara and San José (north of Highway 101), and up to 20 mgd to Valley Water's retailers Serves Valley Water retailers through a dedicated purified water pipeline to Piedmont Valve Yard (i.e., blending location near Penitencia WTP) for delivery via Milpitas Pipeline and East Pipeline			$605	$24.1	$2,600	$2,200
Portfolio 2 Combines effluent from Palo Alto RWQCP and Sunnyvale WPCP and purifies at a 24.5-mgd regional AWPF located in Palo Alto (2a) or Sunnyvale (2b)	**2a: PA (+SV) GWR**	Delivers 17,000-23,000 AFY to LGRP for GWR	**Option 1*** **Option 2** **Option 3**	Blend ROC with residual final effluent and discharge at existing outfall Discharge at a new shallow outfall in San Francisco Bay Discharge at a deep-water outfall north of Dumbarton Bridge	$800	$22.5	$3,000-$4,000	$2,400-$3,100
	2b: SV (+PA) GWR	Delivers 17,000-23,000 AFY to LGRP for GWR	**Sole Option**	Discharge ROC at a new shallow-water outfall at Guadalupe Slough for enhanced mixing	$805	$21.6	$3,000-$3,900	$2,400-$3,100
Portfolio 4 Purifies effluent from Palo Alto RWQCP and Sunnyvale WPCP at separate regional facilities, including: 14-mgd Palo Alto AWPF and 10.5-mgd Sunnyvale AWPF	**4: PA/SV GWR**	Delivers a combined 17,000-23,000 AFY to LGRP for GWR	**Option 1*** **Option 2** **Option 3**	Blend ROC with residual final effluent and discharge at existing outfall Discharge at a new shallow outfall in San Francisco Bay Discharge at a deep-water outfall north of Dumbarton Bridge	$850	$23.0	$3,200-$4,300	$2,500-$3,300
			Sole Option	Discharge ROC at a new shallow-water outfall at Guadalupe Slough for enhanced mixing				
Morgan Hill Options	**MH-1: NPR+**	Delivers 2,900 AFY of NPR+ from SBWR to a new Morgan Hill recycled water system [b]	Not applicable		$70	$2.6	$2,200	$1,700
	MH-2: GWR	Delivers 1,900 AFY from a Morgan Hill 2.5-mgd satellite WWTP and 2.1-mgd AWPF to a recharge facility [c] in Morgan Hill for GWR	**Sole Option**	Lined evaporation pond in Gilroy	$125	$6.9	$7,200	$6,100
	MH-3: SWA	Delivers 1,900 AFY from a Morgan Hill 2.5-mgd satellite WWTP and 2.1-mgd AWPF to Anderson Reservoir for SWA			$145	$7.2	$8,000	$6,600

[a] *Cost estimates are rounded up to the nearest $5M for capital costs, $100k for O&M costs, and $100 for life-cycle unit costs.*

[b] *MH-1: NPR+ cost estimate includes new recycled water distribution system cost from the 2015 South County Recycled Water Master Plan Update, projected to 2019 dollars (SCRWA, 2016).*

[c] *Delivery point requires further evaluation; preliminary design assumes San Pedro Ponds.*

6.5 Evaluation and Risk

The Project Team created two tools to compare portfolios: an evaluation tool and a risk tool. The evaluation tool compares portfolios relative to one another based on prioritization criteria identified by Valley Water and its Partner Agencies. The risk tool supports assessment of each portfolio separate from the overall evaluation focusing on aspects that may disrupt, delay, or halt projects and considering the likelihood and consequence of risks. The tool returns a calculated composite risk score for each portfolio. ***Appendix A-7*** (Evaluation and Risk Tools) provides detailed descriptions of the approaches for developing and using the tools to compare portfolios, and brief summaries follow in this section.

6.5.1 Evaluation Tool

In October 2018, Valley Water and its Partner Agencies reached collective agreement on five evaluation criteria representing program goals. A collective 19 sub-criteria further define the 5 criteria and help differentiate portfolios in scoring (Table 6-14). Several program goals important to Valley Water and its Partner Agencies are not reflected in the criteria or sub-criteria because the evaluation tool focuses aspects that distinguish portfolios from one another. An example of a project goal not reflected in the criteria (i.e., does not set apart portfolios) is that all portfolios protect groundwater and surface water quality, as required by Valley Water.

As conditions change and new information becomes available, portfolios will perform differently with respect to the criteria and sub-criteria, and results of the evaluation tool will change.

Table 6-14. Criteria and Sub-criteria Built into the CoRe Evaluation Tool

Criteria	Sub-Criteria (used to further define and score criteria)
Economics	Estimated life-cycle costs: 30-year
Countywide (regional) supply reliability	• Projected 2040 PR annual purified water production • Purified water delivery point utilization • Local reuse benefit – retains reuse supply in same sewer service area
Environmental impacts/ benefits and sustainability	• Minimizing carbon footprint (evaluated using energy use as a surrogate for carbon emissions) • Environmental and social justice • Equity in supply benefits (with respect to water rights)
Ease of implementation and regulatory compliance	• Partnerships/collaboration • Public health regulatory considerations • Environmental compliance regulatory considerations • Design readiness • Anticipated permit requirements • Public acceptance/support
Engineering feasibility	• Need for pilot study (treatment technology proven at full scale) • Pipeline construction • Land acquisition / ownership • Site preparation requirements • Ease of operation

To demonstrate functionality, the Project Team used a variety of weighting scenarios in the evaluation tool to change the relative importance of criteria and sub-criteria in scoring the North County portfolios and South County options. ***Appendix A-7*** includes scenario outcomes. For all four weighting scenarios explored by the Project Team, Portfolio 1a (SJ GWR) outperforms other North County portfolios. For South County options, MH-1 (NPR+) outperforms Morgan Hill NPR from SCRWA, and MH-2 (GWR) outperforms MH-3 (SWA).

6.5.2 Risk Tool

The Project Team identified risks in seven categories with input from reuse subject matter experts, water industry guidance (such as Water Research Foundation's Reference Manual 4715; Water Research Foundation, 2019), Valley Water staff, and Partner Agencies. The Project Team qualitatively analyzed risks of each portfolio/option considering likelihood and consequence(s) of a particular risk occurring and mitigation strategies that could eliminate the risk or reduce its impact.

Example results from the risk assessment tool for North County portfolios and South County options are presented in Figure 6-14 and ***Appendix A-7.*** In this example, Portfolios 1a (SJ GWR) and 2a (PA [+SV] GWR) return the lowest composite risk scores based on the Project Team's input for each of seven risk categories.

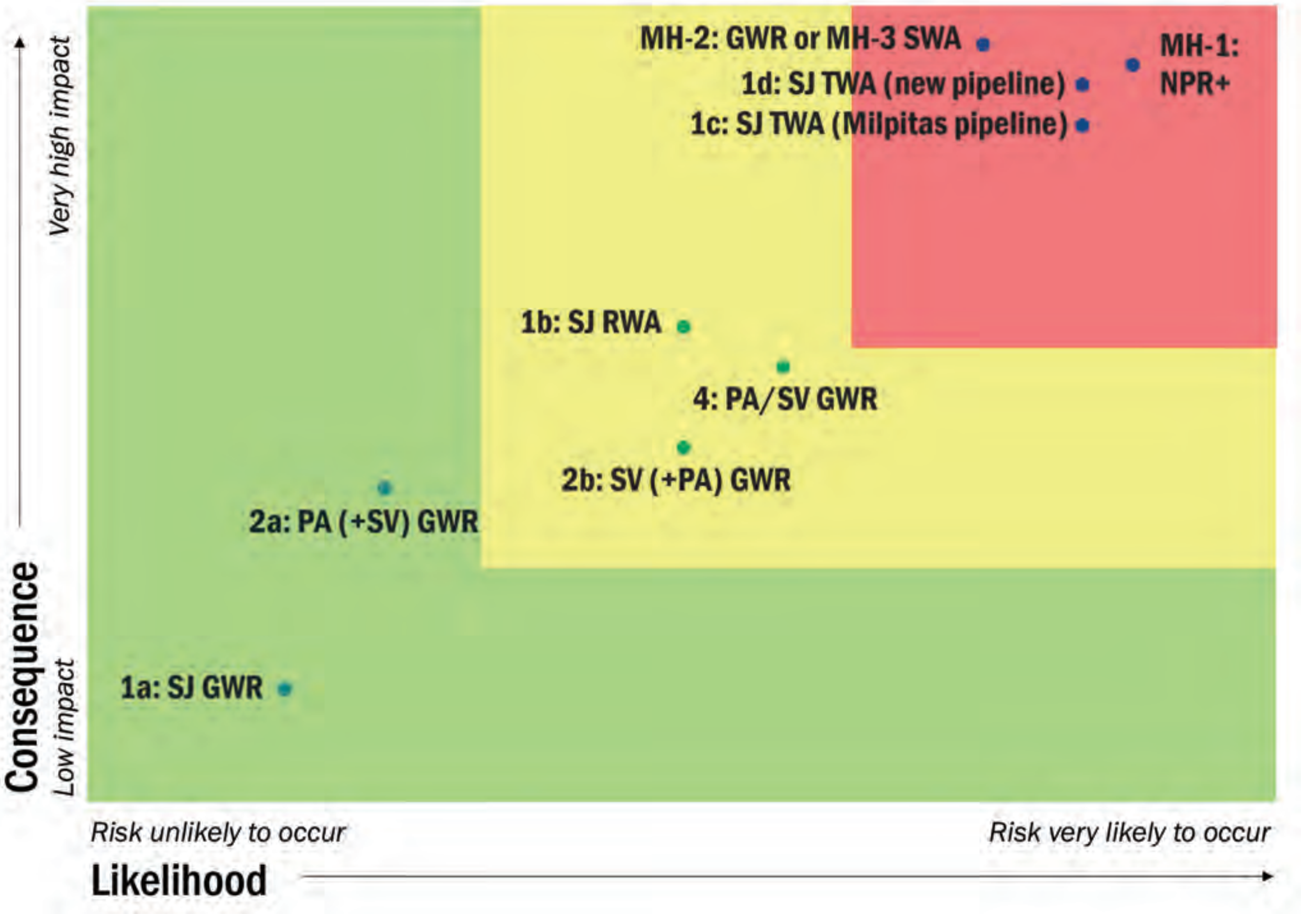

Figure 6-14. Example of risk assessment tool results to compare CoRe portfolios and options

Note: Risk of Portfolios 1c (SJ TWA, Milpitas Pipeline) and 1d (SJ TWA, new pipeline) may drop following the state's adoption of DPR regulations, anticipated as soon as 2023.

6.5.3 ROC Management Strategies Evaluation

Under a separate but related project, Valley Water and its ROC Management Strategies project consultant (GHD) evaluated various options for managing the ROC waste stream considering anticipated compliance with the SF Bay Basin Plan, NPDES permits, and WDR. The results of the ROC strategies evaluation are documented in detail in the *Evaluation of ROC Management Options Final Report* (Valley Water, 2020a), attached as ***Appendix G.*** To distill the evaluation results, Table 6-15 summarizes benefits and challenges of the individual strategies GHD evaluated and includes recommended next steps for Valley Water to consider during future phases of project selection and implementation.

Table 6-15. Overview of ROC Management Strategies Evaluation Prepared by GHD (Valley Water, 2020a)

ROC Management Strategy	Applicable AWPF Locations	Benefits	Challenges	Recommended Next Steps
1. Existing Outfall Use existing outfall and rely on blending with current discharge	**San José Portfolios:** 1a, SJ GWR 1b: SJ RWA 1c: TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline	• Anticipated compliance with applicable discharge requirements, based on GHD's analysis • Anticipated to meet target AWPF production capacity, based on GHD's analysis • Likely feasible to permit by 2028 due to avoidance of developing a new outfall	• Involves securing a new permit that requires coordination between Valley Water and San José • Requires inter-agency agreements to commingle discharge flows	• Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Obtain inter-agency agreements to define roles and responsibilities for permit compliance

	Palo Alto Portfolios:
	2a: PA (+SV) GWR
	4: PA/SV GWR
	Sunnyvale Portfolios:
	2b: SV (+PA) GWR
	4: PA/SV GWR
		• Anticipated compliance with applicable discharge requirements, based on GHD's analysis, so long as AWPF production rate is lowered to ensure sufficient blending
		• Likely feasible to permit by 2028 due to avoidance of developing a new outfall
			• Uncertainty regarding the willingness of the Regional Board to consider alternative compliance assessments such as mass-loading based objectives
			• Limited recycled water capacity due to minimum discharge needed for dilution; capacity ranges depending on assumptions, shown below as a percent of target capacity
			  • Palo Alto AWPF: Portfolio 2a (PA [+SV] GWR): 46-82% and Portfolio 4 (PA/SV GWR): 27-68%
			  • Sunnyvale AWPF: Portfolio 2b (SV [+PA] GWR): 3-51% and Portfolio 4 (PA/SV GWR): 52-88%
			• Involves securing a new permit that requires coordination between Valley Water and Palo Alto and/or Sunnyvale
			• Requires inter-agency agreements to commingle discharge flows
				• Further discuss regulatory approach with Regional Board and other agencies with jurisdiction and determine whether alternative limits such as mass-based requirements could be applied
				• Obtain inter-agency agreements to define roles and responsibilities for permit compliance

2. New Outfall Blend at a new outfall near an existing outfall	**San José Portfolios:** 1a, SJ GWR 1b: SJ RWA 1c: TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline	• Anticipated compliance with applicable discharge requirements, based on GHD's assumptions • Anticipated to meet target AWPF production capacity, based on GHD's analysis	• Dilution with San José discharge in the environment (rather than prior to discharge) may limit ability to receive dilution credit • Uncertainty in feasibility of implementing by 2028, given a new outfall is subject to environmental regulatory requirements (endangered species present) • Involves securing a new permit that requires coordination between Valley Water and San José	• Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for implementing a new outfall • Obtain inter-agency agreements to define roles and responsibilities for permit compliance
3. New Outfall with Enhanced Mixing Discharge at a new enhanced mixing outfall	**San José Portfolios:** 1a, SJ GWR 1b: SJ RWA 1c: TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline **Palo Alto Portfolios:** 2a: PA (+SV) GWR 4: PA/SV GWR) **Sunnyvale Portfolios:** 2b: SV (+PA) GWR 4: PA/SV GWR	• Offers potential for more dilution credit compared to using the existing outfall or a new shallow outfall • Anticipated to meet target AWPF production capacity, based on GHD's analysis • May not require coordination with the Project Partner to obtain an NPDES permit	• Uncertainty in feasibility of implementing by 2028, given a new outfall is subject to environmental regulatory requirements (endangered species present) • Unconfirmed (and not guaranteed) amount of dilution achieved by a new outfall • Permitting uncertainty, considering development of an outfall extension at Palo Alto was not permitted in the 1980s	• Continue to assess potential dilution credit that could be achieved depending on outfall design • Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for implementing a new outfall
4. Deep Water Discharge Outfall Discharge at an existing deep-water outfall (Silicon Valley Clean Water)	**Palo Alto Portfolios:** 2a: PA (+SV) GWR 4: PA/SV GWR)	• Offers potential for more dilution credit compared to using an existing outfall • Based on GHD's analysis, meets target AWPF production capacity	• Unknown capacity of the outfall requires verification • Involves securing a new permit that requires coordination between Valley Water, Silicon Valley Clean Water, and Palo Alto	• Verify capacity and dilution of the existing deep-water outfall • Evaluate schedule requirements for connecting to the existing outfall • Obtain inter-agency agreements to define roles and responsibilities for permit compliance
5. Evaporation Pond Discharge into a lined evaporation pond (in Gilroy)	**Morgan Hill Options:** MH-2: GWR MH-3: SWA	• Provides a potential option for disposing ROC produced in Morgan Hill (far from SF Bay) • Other site-specific benefits may arise after identifying a feasible location	• Requires Valley Water to acquire a significant amount of land • Other site-specific challenges may arise after identifying a suitable location	• Identify a suitable location for the evaporation ponds • Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for connecting to the existing outfall

Section 7:
Potential Future Opportunities and Alternative Elements

Through the CoRe Plan's development, Valley Water and its Partner Agencies considered a wide range of reuse scenarios, including reuse projects identified in the North County portfolios and South County options described in Section 6. In addition, Valley Water and its Partner Agencies also considered opportunities that may be further explored in the future and alternative elements that could replace aspects of the portfolios/options.

7.1 NPR/NPR+ Expansion (featured in all portfolios)

Several Partner Agencies are evaluating potential projects to expand existing recycled water systems. Figure 7-1 shows locations of NPR and NPR+ expansion projects as identified in Partner Agencies' existing recycled water master plans[7]. Projects identified in the figure do not necessarily reflect full potential buildout conditions for each Partner Agency.

As described in more detail in Section 2.3 of ***Appendix A-1***, the Project Team compiled and summarized market potential for future NPR/NPR+ expansion on a Countywide basis and related capital costs as previously studied by Partner Agencies and documented in their respective recycled water master plans. Compared to NPR/NPR+ demands summarized in 2015 UWMPs, recycled water projections in existing recycled water master plans are significantly higher. Key factors contributing to this discrepancy are that projects identified in recycled water master plans are: (a) not necessarily confirmed to be feasible or cost-effective, and (b) not consistently reflective of full costs, such as retrofits and treatment to improve NPR quality.

Depending on site- and case-specific circumstances, use of recycled water for NPR can be a logical, cost-effective water management strategy. Many variables play a role in that determination, including the need for supplemental water supply of a certain quality, within an established timeframe, and during specific conditions.

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[7] Sunnyvale is not currently funding expansion of its recycled water system. Potential NPR/NPR+ expansion projects listed in this report are based on the City of Sunnyvale's 2013 Feasibility Study for Recycled Water Expansion.

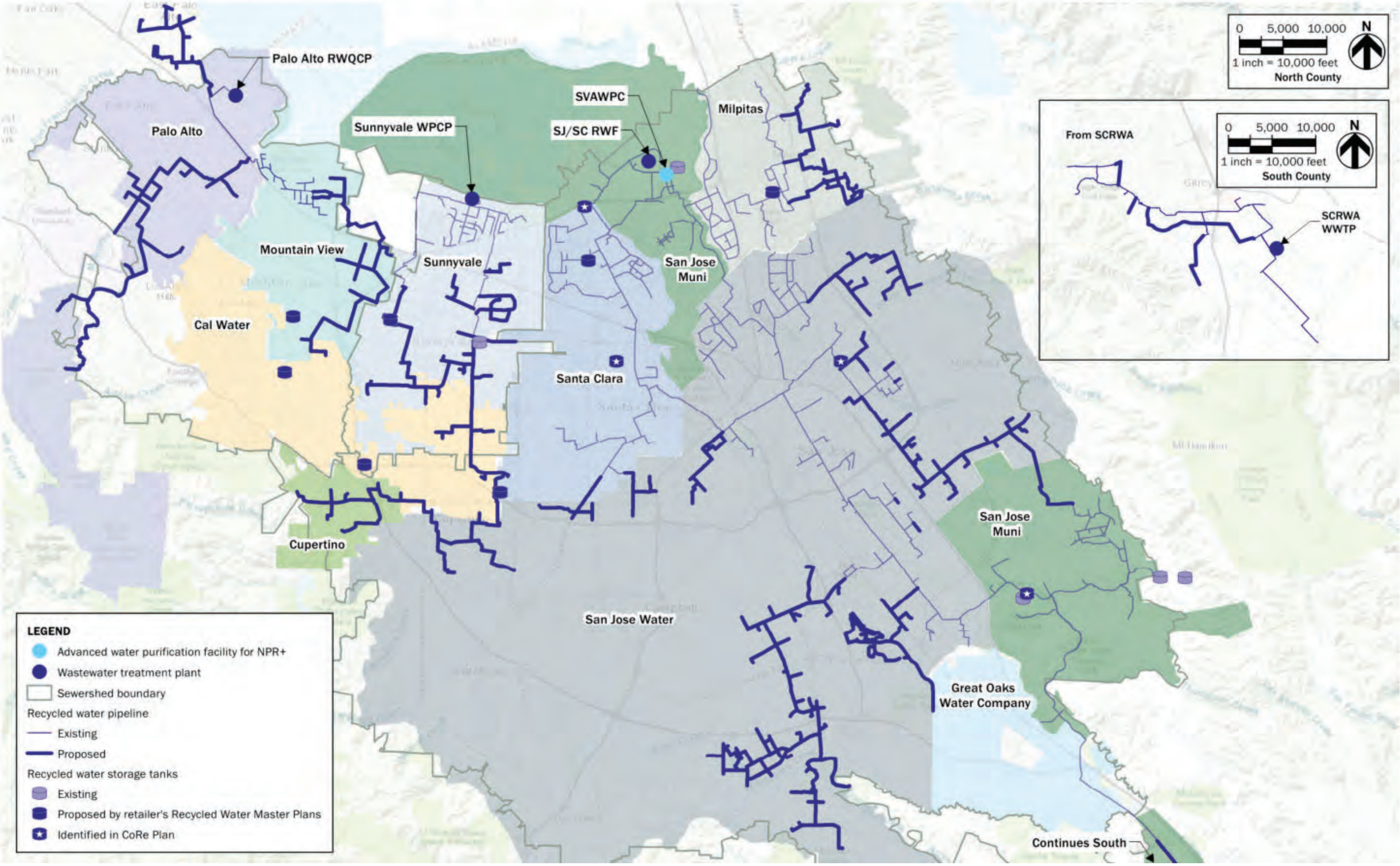

Figure 7-1. Potential future recycled water distribution system expansions throughout Santa Clara County and water retailer service areas

Note: Recycled water infrastructure improvements reflect NPR retailers' recycled water master plans and are currently undefined for City of Santa Clara and San José Municipal Water service areas.

7.2 Interties between Recycled Water Systems

Physically interconnecting recycled water systems serves several potential functions, including:

Reliability: If an outage occurs in one system, available capacity from an adjoining system could be used. Supply from an adjoining system could also support pipeline maintenance activities, such as shutdowns of transmission mains.

Peak demand supply mitigation: Peak day and peak hour demands are a challenge in some systems, and available supply from an adjoining system could be leveraged to meet demands.

Freeing up effluent for PR: By meeting NPR demands of adjacent systems, the amount of supply offset could provide more flow for PR or ROC dilution. For example, if Sunnyvale's NPR demand were met by SBWR, Sunnyvale could provide more supply for PR or ROC dilution. Vice versa, if SBWR's NPR+ expansion was met using effluent from Sunnyvale, SBWR would be able to confidently meet NPR+ demands even during dry years, allowing for supply for PR.

In addition to pipelines, interties may require pump stations, pressure-reducing valves, metering, or other facilities depending on intended function and planned operations. Further, interties between some recycled water distribution systems may require treatment improvements (i.e., an AWPF for NPR+) to avoid negatively impacting an adjoining system's water quality. Over the past decade, Valley Water and Partner Agencies studied pipeline alignments for several intertie opportunities in North County, including the following.

- **Sunnyvale-SBWR interties.** Three intertie options were considered to connect Sunnyvale and SBWR, including: one effluent intertie to convey secondary effluent from Sunnyvale WPCP to the SJ/SC RWF or SVAWPC, and two recycled water intertie alignments (one northern and one southern connector).
- **Sunnyvale-Palo Alto/Mountain View intertie.** An intertie could connect an existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field.

Table 7-1 briefly describes these interties and shows estimated capital costs, as identified in various past studies. For the two Sunnyvale-SBWR recycled water intertie alignments, capital cost estimates vary based on conditions and assumptions used in past studies. Figure 7-2 identifies alignments considered. A more detailed discussion of cost and design assumptions is included in Section 2.3 of ***Appendix A-1.***

Table 7-1. Summary of Potential Recycled Water System Interties

Intertie	Description	Length/ Diameter	Capital Cost ($M)
Sunnyvale – SBWR interties			
1. Effluent intertie	30" pipeline to convey up to 10 mgd of secondary effluent from the Sunnyvale WPCP to the SJ/SC RWF or SVAWPC. Involves tunneling through Bay soils and high groundwater areas.	32,000 LF at 30"	$86
2. Recycled water intertie, northern connector	24" or 30" pipeline connecting an existing 30" SBWR pipeline (at Lafayette Drive and Tasman Road) to an existing 24" Sunnyvale pipeline (at Sunnyvale East Channel and Persian Drive). Hydraulically modeled for peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale.	16,000 LF at 24"	$15
		15,000 LF at 30"	$24 [a] - $51
3. Recycled water intertie, southern connector	16" or 30" pipeline connecting an existing 16" SBWR pipeline (at Homestead Road and Las Palmas Drive) to existing Wolfe Road pipeline. Hydraulically modeled for peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale	12,000 LF at 16"	$7
		12,000 LF at 30"	N/A
Sunnyvale-Palo Alto/ Mountain View intertie			
4. Recycled water intertie	16" pipeline connecting to two other 16" pipelines: one existing (on Enterprise Way in Sunnyvale) and one new (located in Moffett Field, part of a potential Mountain View NPR system expansion)	18,600 LF at 16"	$16 [a]

[a] *For more detail, refer to Appendix A-1, Section 2.3 and Appendix A-6 (cost tables).*

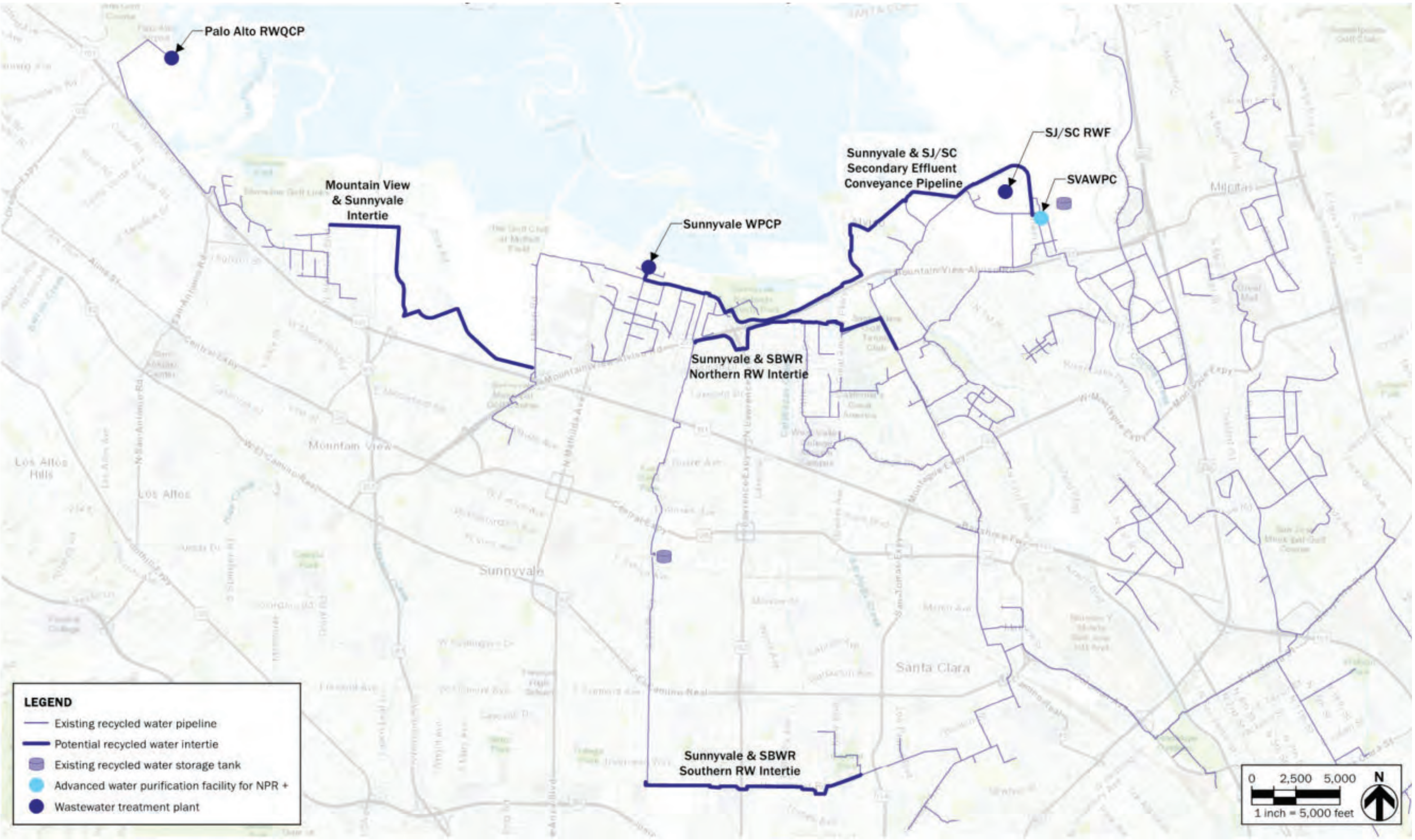
Palo Alto RWQCP
Mountain View & Sunnyvale Intertie
Sunnyvale WPCP
Sunnyvale & SJ/SC Secondary Effluent Conveyance Pipeline
SJ/SC RWF
SVAWPC
Sunnyvale & SBWR Northern RW Intertie
Sunnyvale & SBWR Southern RW Intertie
Mountain View
Los Altos Hills
Los Altos
Sunnyvale
Santa Clara
Milpitas
LEGEND
Existing recycled water pipeline
Potential recycled water intertie
Existing recycled water storage tank
Advanced water purification facility for NPR +
Wastewater treatment plant
0
2,500
5,000
1 inch = 5,000 feet
N

Figure 7-2. Potential interties between recycled water systems

7.3 Potential Future Reuse Opportunities, Design Variations, and Alternative Elements

Valley Water and its Partner Agencies may consider adapting the portfolios and options summarized in Section 6 to further increase benefits, such as operational flexibility. Some potential future reuse opportunities are summarized below, along with alternative project elements that are not incorporated into baseline components of any portfolio but may be considered through either a substitution (e.g., an alternate pipeline alignment) or "add-on" (e.g., new interties between NPR+ systems).

Resized design capacity of AWPFs and/or phased implementation

Several conditions may warrant revisiting and revising the design capacity of AWPFs considered to date to "right-size" projects. For example, Valley Water may consider impacts of source water availability—that is, long-term agreements with Partner Agencies guaranteeing a minimum flow to support potable reuse—along with any potential refinements to supply planning that change Valley Water's defined target for potable reuse (currently 24,000 AFY) or effluent flow needed for ROC management strategies that involve blended discharge.

Phased implementation would allow for incrementally increasing the capacity of an AWPF through strategies like modular construction. However, it is critical to consider the anticipated buildout details from the outset, such that design of conveyance capacity and intended reuse type(s) to be delivered support the envisioned buildout.

Optimized/resized design of conveyance capacity

The Project Team developed preliminary design of conveyance infrastructure using pipeline diameters consistent with those considered under the Final Expedited Purified Water Program Plan (Valley Water, 2018). However, Valley Water purposefully sized the 48-inch diameter pipelines in the Expedited Purified Water Program Plan to be larger than needed, such that the system would allow for increased flow if Valley Water secured additional source water. Based on a high-level estimate, reducing the Portfolio 1a (SJ GWR) 48-inch pipeline of about 18.1 miles from San José to LGRP to 42-inch or 36-inch diameter would reduce capital costs by an amount on the order of $45M (15%) and $90M (30%), respectively. Design refinement would be needed to confirm the costs savings, as O&M implications have not been assessed.

Pipeline extension from LGRP to Rinconada WTP for RWA

To increase operational flexibility of portfolios involving GWR at LGRP, a pipeline extension and pump station would allow the opportunity to send purified water to Rinconada WTP for RWA. This RWA variation would improve potable reuse supply yield at times when the groundwater basin reaches capacity and recharge is not possible. Before this pipeline scenario is implemented, AWPFs configured for GWR would require treatment upgrades to align with anticipated regulatory requirements for RWA. Operational analysis is needed to determine how purified water would be blended with existing sources of raw water and how resulting water quality would change.

Operational flexibility for DPR portfolios (San José AWPF to Penitencia WTP) via Central Pipeline

Portfolios 1b (SJ RWA), 1c (SJ TWA, Milpitas Pipeline), and 1d (SJ TWA, new pipeline) consider DPR from a San José AWPF, and each features a delivery point proximate to Penitencia WTP, thus allowing an access point to the Central Pipeline—an existing raw water conveyance system originating from the SBA Terminal Tank at the Penitencia WTP leading to LGRP and Rinconada WTP—and providing increased operational flexibility. This scenario could allow Valley Water to send purified water from a San José AWPF and route around Penitencia WTP to flow to LGRP for GWR in the interim timeframe, and once DDW has finalized DPR regulations, RWA via Penitencia or TWA may be possible. Operational analysis is needed to determine whether and/or how Rinconada WTP would blend purified water with existing sources of raw water.

Alternate alignments from Palo Alto to LGRP

Portfolios 2a (PA [+SV] GWR) and 4 (PA/SV GWR) include conveyance of purified water from an AWPF in Palo Alto south to LGRP. Four possible route variations were considered, though one default alignment was selected for the purpose of determining costs and relative pipe lengths across portfolios. By default, Portfolios 2a (PA [+SV] GWR) and 4 (PA/SV GWR) both use an eastern route that bypasses Sunnyvale. Alternate routes, shown as dashed lines on the Portfolios 2a (PA [+SV] GWR) and 4 (PA/SV GWR) figures in ***Appendix A-1****,* include a western route that bypasses Sunnyvale, and two routes (eastern and western) that travel through Sunnyvale. Routes that bypass Sunnyvale are substantially shorter and therefore save pipeline and pumping costs; whereas routes that travel through Sunnyvale allow PR flow to be diverted to the Sunnyvale WPCP for blending with recycled water to produce NPR+.

Alternate alignment from Sunnyvale to LGRP

By default, Portfolio 2b (SV [+PA] GWR) includes the eastern alignment to convey purified water from a Sunnyvale AWPF to LGRP, though there is also a western alignment option shown as a dashed line on the Portfolio 2b (SV [+PA] GWR) figure in ***Appendix A-1****.*

West County TWA

Portfolios 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) explore using SJ/SC RWF source water for TWA because that allows for a case study that presents the full range of potable reuse options for comparison against one another. However, other TWA opportunities exist throughout the County.

One potential future TWA opportunity, West County TWA, builds on a concept Valley Water is already considering and relies on a Palo Alto AWPF. This option involves extending Valley Water's existing treated water pipeline, the West Pipeline, from its current end point near Foothill Expressway in Los Altos to a location near Page Mill Road in Palo Alto. The West County TWA scenario would deliver up to 24,000 AFY of purified water from a Palo Alto regional AWPF to the extended West Pipeline for purified water delivery throughout the County. Like Portfolio 2a (PA [+SV] GWR), effluent would be conveyed from the Palo Alto RWQCP and Sunnyvale WPCP to a 24-mgd AWPF that would be constructed at the former Los Altos Treatment Plant site. Though this scenario was not carried forward to portfolios reflected in this CoRe Plan, preliminary design details are included in ***Appendix A-1*** and ***Appendix A-8***[8], and related costs are shown in ***Appendix A-6****.*

South County TWA

Two potential South County TWA options have been discussed with staff from Morgan Hill and Gilroy. One option involves a satellite WWTP and AWPF in Morgan Hill before adding the purified product water to the Morgan Hill drinking water distribution system. This option would likely have a high life-cycle unit cost given the high level of treatment, lack of ROC management options, and limited yield. A second TWA option would use water treated at a new AWPF adjacent to SCRWA in Gilroy and deliver purified water to the Gilroy drinking water distribution system. This option would likely have similar limitations as the first South County TWA option and limit supply available for NPR use in Gilroy.

AWPF for NPR+ in Sunnyvale

Sunnyvale does not have a need for NPR+ in its service area but would need to provide water quality consistent with SBWR or PA/MV NPR+ if interconnecting recycled water systems. Portfolios 2b (SV [+PA] GWR) and 4 (PA/SV GWR) consider an AWPF located in Sunnyvale that assumes an additional 0.5 mgd of design capacity to produce purified water for blending with recycled water for NPR+ in Sunnyvale. Portfolio 2a (PA [+SV] GWR) includes a 2,000-foot, 12-inch pipeline that carries 0.5 mgd of purified water from the 48-inch Palo Alto AWPF to the LGRP pipeline south to the Sunnyvale's San Lucar NPR storage tank. Purified water added to San Lucar would produce NPR+ for distribution throughout Sunnyvale's RWS.

Additional AWPF in San José for NPR+

Referred to as an "SVAWPC expansion" in some past studies, an additional AWPF may be considered in San José to increase purified water production to meet increasing demands for NPR+ while maintaining a TDS level of 500-550 mg/L year-round.

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[8] ***Appendix A-8*** refers to this concept as Portfolio 7a: PA (+SV) TWA.

Section 8:
Implementation Planning

Given the wide range of reuse scenarios considered in this CoRe Plan, implementation planning needs to incorporate flexibility and support future decision-making.

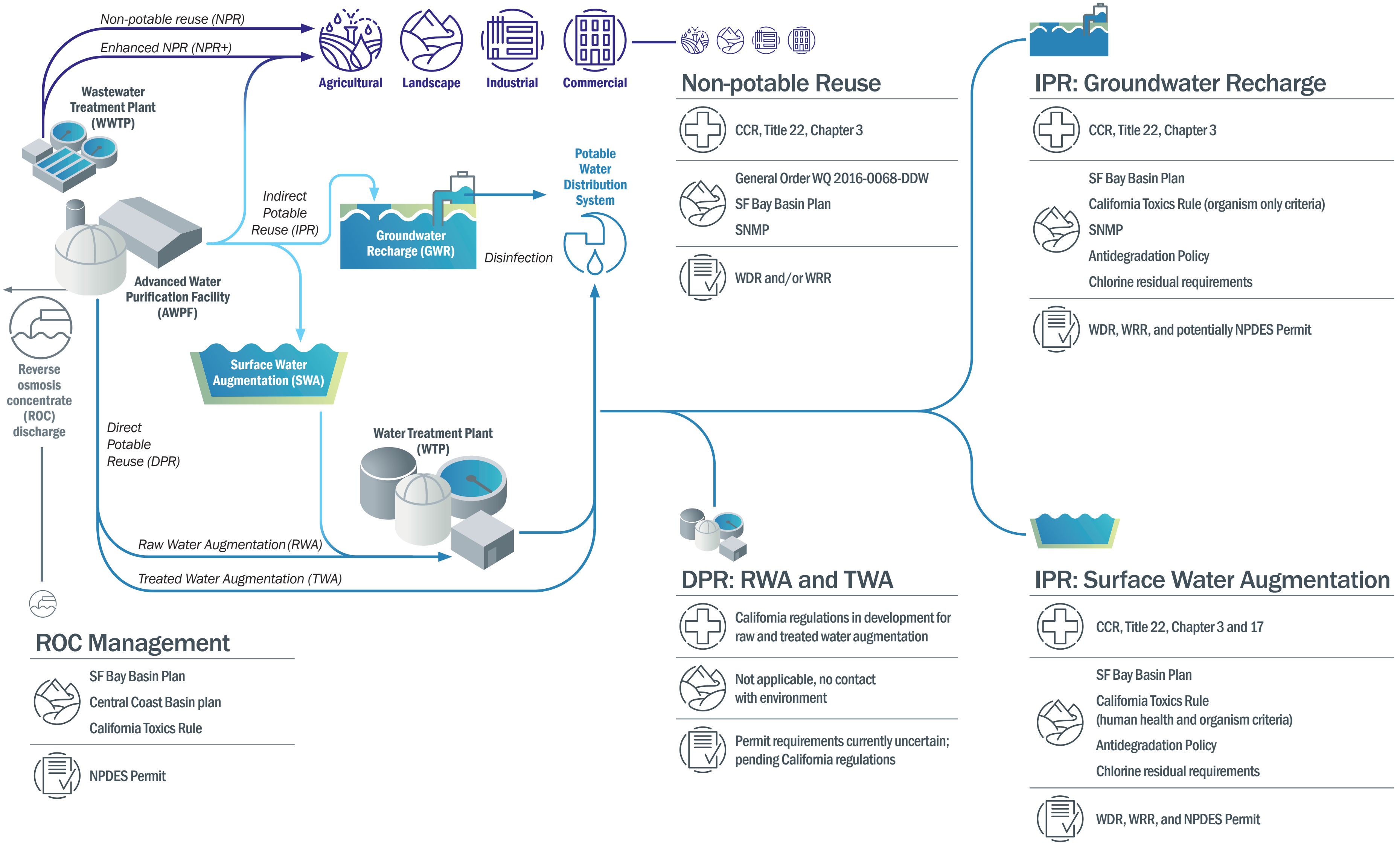
8.1 Regulatory Compliance Considerations

Assessing reuse opportunities in terms of regulatory compliance helps identify issues that may impact implementation feasibility or future permitting. While this section summarizes the strategy for regulatory compliance, ***Appendix B-1*** (Regulatory Compliance Strategy TM) addresses the topic in substantially more detail.

The regulatory analysis identifies the following:

1. **Key regulatory considerations applicable to reuse opportunities that may impact public health or environmental compliance**
2. **Differences between reuse opportunities in terms of potential regulatory and permitting challenges**
3. **Future actions that are required or may assist with regulatory and permitting efforts**

Opportunities featured and evaluated in the CoRe Plan include potable reuse portfolios in North County that consider GWR, RWA, and TWA and non-potable and potable reuse options in South County that consider NPR+, GWR, and SWA. Figure 8-1 summarizes relevant regulations, permits, and required documentation for each reuse type evaluated in the CoRe Plan.


Non-potable reuse (NPR)
Enhanced NPR (NPR+)
Agricultural
Landscape
Industrial
Commercial
Wastewater Treatment Plant (WWTP)
Indirect Potable Reuse (IPR)
Groundwater Recharge (GWR)
Potable Water Distribution System
Disinfection
Advanced Water Purification Facility (AWPF)
Reverse osmosis concentrate (ROC) discharge
Surface Water Augmentation (SWA)
Water Treatment Plant (WTP)
Direct Potable Reuse (DPR)
Raw Water Augmentation (RWA)
Treated Water Augmentation (TWA)

Non-potable Reuse

CCR, Title 22, Chapter 3

General Order WQ 2016-0068-DDW
SF Bay Basin Plan
SNMP

WDR and/or WRR

IPR: Groundwater Recharge

CCR, Title 22, Chapter 3

SF Bay Basin Plan
California Toxics Rule (organism only criteria)
SNMP
Antidegradation Policy
Chlorine residual requirements

WDR, WRR, and potentially NPDES Permit

DPR: RWA and TWA

California regulations in development for raw and treated water augmentation

Not applicable, no contact with environment

Permit requirements currently uncertain; pending California regulations

IPR: Surface Water Augmentation

CCR, Title 22, Chapter 3 and 17

SF Bay Basin Plan
California Toxics Rule (human health and organism criteria)
Antidegradation Policy
Chlorine residual requirements

WDR, WRR, and NPDES Permit

ROC Management

SF Bay Basin Plan
Central Coast Basin plan
California Toxics Rule

NPDES Permit

Figure 8-1. Summary of relevant regulations, permits, and required documentation for non-potable and potable reuse

8.1.1 Regulatory Compliance Evaluation

A rubric was developed for each potable reuse type to assess the relative difficulty or ease of complying with associated regulations and permitting requirements.

Existing regulations for GWR and SWA informed a set of six criteria for evaluating potable reuse opportunities.

- Pathogen removal
- Chemical removal
- Source control
- Monitoring and controls
- Retention and response time
- Technical, managerial, and financial (TMF) capacity

The same six criteria applied to evaluations of RWA and TWA portfolios, though ranking DPR opportunities required assumptions since DDW has not yet developed applicable regulations. For comparison, Table 8-1 shows the rankings as unfilled circles (less complex) to filled circles (more complex) in terms of regulatory compliance.

Table 8-1. Regulatory Complexity related to Public Health Considerations in the Potable Reuse Portfolios

Reuse type	GWR	SWA	RWA	TWA	
Portfolio / Option	1a: SJ GWR 2a: PA (+SV) GWR 2b: SV (+PA) GWR 4: PA/SV GWR MH-2: GWR	MH-3: SWA	1b: SJ RWA	1c: SJ TWA, Milpitas Pipeline	1d: SJ TWA, new pipeline
Pathogen removal	○	○	○	○	
Chemical removal	○	○	○	◒	
Source control	○	○	◒	◒	
Monitoring and control	○	○	◒	●	◒
Retention and response time	○	○	◒	◒	
TMF capacity	◒	◒	●	●	

○ *low complexity* ◒ *medium complexity* ● *high complexity*

The results span from straightforward compliance for GWR portfolios to increasingly complex for RWA and TWA. Increasing the level of certainty around criteria such as specific regulatory considerations and multi-agency coordination could reduce complexity of some portfolios. Future actions that may increase regulators' comfort with these issues could involve demonstrating public health protectiveness of a candidate treatment train or proper functioning of an enhanced monitoring and control system.

The portfolios must also demonstrate compliance with environmental discharge considerations by presenting a plan to address ROC waste streams and—in all but the DPR portfolios—purified water releases to the environment. Table 8-2 summarizes the portfolios' rankings in terms of environmental considerations and associated regulatory compliance.

Table 8-2. Regulatory Complexity related to Discharge of Purified Water to the Environment in the Potable Reuse Portfolios

Reuse type	GWR	SWA	RWA/TWA
Portfolio / Option	**1a: SJ GWR 2a: PA (+SV) GWR 2b: SV (+PA) GWR 4: PA/SV GWR MH-2: GWR**	**MH-3: SWA**	**1b: SJ RWA 1c: SJ TWA, Milpitas pipeline 1d: SJ TWA, new pipeline**
SF Basin Plan	○	○	**N/A**
California Toxics Rule	○	◒	**N/A**
SNMP	○	**N/A**	**N/A**
Anti-degradation	○	○	**N/A**
Chlorine residual	○	○	**N/A**

○ *low complexity* ◒ *medium complexity* ● *high complexity*
N/A indicates options that do not involve discharges to the environment

8.1.2 Recommended Next Steps for Regulatory Compliance

Several factors can influence the initial snapshot of these rankings, such as: (a) regulators' engagement and feedback on the portfolios, (b) greater clarity regarding future regulatory requirements for DPR, and (c) additional efforts by Valley Water and its partners to address or resolve the issues ranked as medium or high complexity.

Strategies to overcome some of these issues and uncertainties include the following.

- Continued partner engagement on interagency agreements
- Demonstration testing of potable reuse treatment systems
- Evaluation of enhanced monitoring and control systems
- Pathogen monitoring campaigns to support higher WWTP log reduction value (LRV) credits
- Evaluation of WTP performance and crediting in RWA scenarios
- Further coordination with the SF Bay Regional Board to confirm the feasibility and permitting requirements of ROC management strategies and AWPF product water releases for all portfolios

With greater clarity on the potable reuse project(s) and/or portfolio moving into future phases, additional reuse-specific studies may be needed. Valley Water should coordinate with staff from DDW and the SF Bay Regional Board and consult the IAP to confirm the need for such studies, which could include the following.

- Tracer studies to confirm aquifer retention time (GWR) or to validate hydrodynamic models (SWA)
- Hydrodynamic studies to confirm mixing and dilution requirements in SWA reservoirs
- Studies to evaluate anticipated blending ratios in the SWA, RWA, and TWA portfolios
- Studies related to ROC discharge and AWPF product water release to confirm anticipated regulatory compliance

The complete process of implementing potable reuse will involve various steps over multiple years. The process starts with the development and testing of a potable reuse concept before moving forward with design, permitting, construction, and start-up of the system. Two recently permitted projects that were pursued on expedited timelines—Monterey One Water's GWR project and the City of San Diego's SWA project—required more than 10 years for completion.

8.2 Rate Impacts

As the groundwater management agency and primary wholesale water supplier for Santa Clara County, Valley Water is responsible for actively managing and replenishing groundwater basins and operating and maintaining a large, complex water system that includes three pump stations, three conventional WTPs, one AWPF, 10 surface water reservoirs with about 170,000 AF total storage, nearly 150 miles of pipe (ranging from 12-inch to 60-inch diameter), and nearly 400 acres of recharge facilities. Groundwater production charges and treated water charges paid by retail water suppliers support the costs of operating and maintaining the system, repairing/replacing aging infrastructure, and providing other services required to maintain clean, safe, reliable groundwater supplies.

The cost of implementing reuse opportunities identified in this plan would be met by ratepayers within the relevant groundwater benefit zones. Using preliminary cost estimates documented in previous drafts of this plan, Valley Water staff estimated the anticipated incremental percent increase to the municipal and industrial groundwater production charges for each portfolio and option for a planning period of fiscal years (FY) 2022 to 2030. Incremental rate increases would be in addition to anticipated rate increases unassociated with this plan's portfolios and options.

Valley Water staff estimated that implementation of a North County portfolio would result in an incremental increase to the Groundwater Benefit Zone W-2 groundwater production charge ranging from 1.6% to 1.9% per year, depending on the portfolio. Rate impacts may be lower with receipt of external funding such as grant awards or low interest loans.

In South County, the implementation of a Morgan Hill option was estimated to incrementally increase the Groundwater Benefit Zone W-5 groundwater production charge by a range of 2.2% (MH-1 [NPR+]) to 4% (MH-3 [SWA]) per year. Based on recently updated cost estimates, rate impacts for MH-2 (GWR) and MH-3 (SWA) are likely to be higher than this estimated increase. Note that Groundwater Benefit Zones W-7 and W-8 in South County do not benefit from the provision of recycled water.

While the planning level potable reuse cost estimates exceed those of existing supplies, Valley Water's current (FY 2020-21) groundwater production charge of $1,374/AF for North County municipal and industrial users is anticipated to surpass $3,000/AF by FY 2029-30 to maintain with necessary investments in water supply infrastructure and increasing operations and maintenance costs. Santa Clara County is rapidly approaching a tipping point where purified water is cost competitive with other supplies.

8.3 Public Outreach and Engagement

Public awareness, understanding, and support are integral to the success of any potable reuse program and often present a greater challenge to implementation compared to technical feasibility. Even when technology does not stop potable reuse projects from proceeding, politics and public perception have been common roadblocks. These challenges are not insurmountable; though, successful public outreach requires careful planning, cohesion among partners, commitment to consistent and transparent communication, and follow-through.

While not yet fully mainstream, potable reuse is a proven approach and yields a reliable, drought-resistant, safe, high-quality drinking water supply. Particularly in the last decade, water suppliers, industry professional associations, and research organizations have invested in robust potable reuse research portfolios to confirm protection of public health and inform regulations. For example, projects demonstrating the effectiveness of treatment processes and failproof strategies have helped assure public health is maintained. In addition to verifying technical feasibility of DPR, a substantial part of the research effort relates to public communications, outreach, and acceptance. In fact, in 2014 Valley Water participated as a utility partner in one such project. The Water Environment & Reuse Foundation's Research Project 13-02, *Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse* involved opinion research including meetings with two local focus groups and a phone survey of 600 randomly selected voters in the County.

Learning lessons from successful water reuse projects.

To reiterate a critical point: technology is rarely responsible for stopping a potable reuse project. If a project does not move forward once the design, siting, and funding elements are in place, public and political opposition is often the barrier. Successful projects have comprehensive, consistent, and sustained public outreach programs. Valley Water intends to build on the momentum of implementing such a program over the last decade and seek additional ways to reach stakeholders and diverse audiences. Expanding this program Countywide can only benefit Valley Water and its Project Partners.

> **Valley Water and its Project Partners can learn and benefit from those that have successfully forged a path for securing public support—and even enthusiastic public support—by understanding and implementing best practices and remaining mindful of pitfalls to avoid.**

Developing a public outreach action plan in collaboration with Partner Agencies and their respective locally elected officials and policymakers.

Alignment on a public outreach and engagement strategy is needed at many levels, particularly between Valley Water and its Partner Agencies. An important early step is committing to executing an ongoing action plan for public outreach that includes collaboration among the project partners and their respective locally elected officials and policymakers. Ideally, this will include those officials and policymakers fully exercising their leadership voices as reuse champions.

To set the direction for future community and ratepayer engagement related to implementing a potable reuse program in Santa Clara County, Valley Water and the Project Team surveyed Partner Agencies through an online poll and compiled their input on preferred public outreach approaches, related opportunities, and key concerns/challenges. Following the online survey, Valley Water and the Project Team hosted a virtual workshop in June 2020 with Partner Agencies and water retailers throughout the County to further explore the approach for future public outreach and engagement related to potable reuse.

Through surveying the partners and receiving real-time input, the Project Team identified some key themes and insights, summarized as follows.

- **Valley Water should lead a coordinated outreach program with local support for implementation.** Partner Agencies and water retailers have strong interest in collaborating regionally to advance potable reuse and relying on Valley Water to lead and fund outreach in next steps for implementation. Most partners noted a lack of adequate internal resources to conduct effective outreach and a lack of confidence with their ability to advance a related outreach program on their own. Project partner involvement, such as conducting local educational and awareness activities and providing financial or staff support, could be fleshed out in a next phase Countywide outreach program.
- **The unique value of potable reuse needs to be articulated.** As Project Agencies have emphasized, among the earliest steps is a need to articulate the strategic and unique value potable reuse opportunities hold for the County in terms of addressing vulnerability of the existing supply portfolio, buffering risk, and strengthening resilience and dry-year supply reliability.
- **A pilot project, such as public taste tests of purified water, may be helpful.** Uncertainty about whether one project or multiple projects will proceed limits Partner Agencies' ability to identify what may be needed to increase effective outreach or whether a pilot for public taste-testing is desirable. Most agencies thought that taste testing could be helpful if/when it is appropriate based on whether a project is moving forward and/or DDW approval has been secured.
- **Issues of greatest concern mirror those of other potable reuse programs.** The Partner Agencies and water retailers identified several challenges and issues of greatest concern related to public outreach that closely resemble those from other potable reuse programs: (1) trust in water purification science and in the utility providing it, (2) quality of the water/what if something goes wrong, (3) project cost/water bill impact, and (4) real time testing and monitoring.

Looking ahead to a Countywide public outreach program.

Valley Water should continue to apply the comprehensive approach described in its *Final Draft Strategic Communication Plan for Recycled Water* (2011) to inform next steps on outreach to advance reuse projects.

In addition, Valley Water's recent public survey can help guide a more widespread countywide outreach program. There are issues still in play, such as ratepayers' tolerance for a potential rate increase. Some key takeaways from Valley Water's 2020 research related to water reuse opinions and attitudes as conducted by EMC, a research firm that specializes in polling, focus groups, and public opinion research consulting:

- The phrase "using advanced purified water for drinking" received an overall positive reaction and appears to be an adequate description of potable reuse. This finding is important: no additional explanation is needed for support of this concept by most of the population.
- Additional information about potable reuse benefits and safety further increases support.
- GWR has the most support (67%), but at least 63% support the concept of RWA (i.e., adding advanced purified water at a WTP) and 58% support the concept of TWA (i.e., introducing purified water directly into the potable distribution system).
- Themes that resonate include environmental benefits, safety of the water, and resilience to a disaster or other unknowns related to water supply.

Yet, interestingly, awareness of water reuse is low. Over 50% of respondents had not heard of recycled water/water reuse. So, while "using advanced purified recycled water for drinking" resonates as a good idea, most of the population seems to be unfamiliar with the use of recycled water, which may be an early flag indicating the need for increased public outreach efforts to proactively improve understanding ahead of project construction and associated rate increases.

Given these findings, Valley Water and Partner Agencies should consider the following eight outreach objectives and potential future actions.

Outreach Objectives and Potential Future Actions

1 Communicate key messages about reuse to external audiences and interested parties.

- Clearly explain why reuse is an important water management strategy with multiple benefits and how recycled and purified water is produced
- Raise awareness about recycled water uses among a broad range of Santa Clara County residents
- Brand recycled water as "high quality, environmentally beneficial, and water-efficient"
- Use potable reuse terminology that resonates with the public, such as "using advanced purified water for drinking"
- Ensure spokespeople are well-trained and informed.
- Translate and communicate in appropriate languages
- Provide timely information to community leaders so that information spreads through communities as they discuss recycled water with their constituencies
- Expand tours and events – virtually for now and in-person when safe
- Use social media to reach a variety of audiences

2 Communicate key messages about reuse to Board members and staff.

- Update elected officials and staff regularly with written and oral communication
- Consider employees as an equally important audience as external audiences
- Practice presentations and test talking points with employees first, before external audiences
- Inform employees first, before external audiences, and address their questions or issues with recycled water and/or potable reuse

3 Communicate key messages about reuse to water retailers and cities throughout the County.

- Seek support of elected local and state representatives for expanding both non-potable and potable reuse
- Use social media platforms as appropriate to reach specific audiences

4 Inform stakeholders about recycled and purified water, including the many possible uses.

- Demonstrate transparency by discussing pertinent aspects reuse such as water quality, regulatory oversight, fail-safe methods, and more
- Partner with local education providers at elementary, middle, and high school and beyond to inform next generations
- Partner with community groups to present information and enlist their support to distribute information about reuse through their communication channels (websites, newsletters and more)
- Provide open channels of communication for questions about recycled water and potable reuse

5 Ensure understanding and acceptance of the science and technology behind purified water and potable reuse.

- Seek assistance from public health and water quality professionals/ experts to communicate with the public about water quality and safety
- Provide successful examples of advanced reuse projects around the state, country, and world
- Focus on the work and opinion of Independent Advisory Panels about water quality and safety of potable reuse

6 Minimize confusion and opposition regarding use of purified water for potable reuse.

- Explain technical aspects of recycled water and potable reuse in layperson's terms using easy-to-understand language and visual aids for leave-behind materials
- Reach broadly into all communities and ensure presentations reach underserved population groups and multicultural audiences
- Work with multicultural elected officials, leaders, and organizations as well as faith-based leaders and organizations to build understanding and support

7 Create and maintain a pathway for all stakeholders to access information.

- Tailor information to groups and address their specific interests and concerns
- Translate all informational materials as needed
- Conduct an annual tracking poll to gauge success in reaching key stakeholders and audiences

8 Seek balanced media coverage throughout the region.

- Find an advocate for purified water within local news organizations
- Provide timely and accurate information to reporters
- Respond quickly to correct inaccurate articles or reports

Find out more online at SANTA CLARA VALLEY WATER NEWS

8.4 Partnerships and Governance

Critical to advancing next steps, Valley Water and its partners need to coordinate closely to formalize institutional arrangements and reach agreement on governance structures. While the scope of this CoRe Plan does not address institutional partnership arrangements or governance, substantial coordination and thought leadership among the project partners has occurred around these topics over many years.

For example, in November 2008, members of Valley Water's Board, San José's City Council, and Santa Clara's Mayor held a Recycled Water Liaison Committee meeting to develop long-term agreement program element options. The group discussed four collaborative agreement models that represent how Valley Water could work together with SBWR to enable increased water reuse in the County. These models, which could still be used to shape new Partner Agency agreements today, include the following.

Funding/Incentive Agreement

Valley Water would provide a unit-based financial incentive (e.g., \$100-\$250/AF) to the Project Partner(s). This option is likely to yield benefits to both Valley Water and the Project Partner(s), such as avoided cost of new water supply acquisition, reduced risk and cost of a water supply shortage, and joint funding opportunities for relevant new capital projects. The parties would need to agree on cost-sharing and responsibilities related to joint facilities on an individual basis.

Customer Contract for Purchase

Valley Water and the Project Partner(s) would negotiate and execute an agreement for the purchase of recycled water in future years. The Partner Agency would retain its role and relationship with existing customers and receive revenue from additional recycled water sales, while Valley Water could ask for a guaranteed supply of recycled water. This agreement structure is like the relationship between West Basin Municipal Water District and the City of Los Angeles, Bureau of Sanitation.

This option is likely to yield benefits to both Valley Water and the Project Partner(s). Valley Water would have the ability to buy available recycled water at contract price and build/operate their own new recycled and/or purified water facilities. The Project Partner(s) would have authority of their own new recycled and/or purified water facilities and existing assets and may receive increased revenue from additional recycled water sales.

Cooperative Agreement

The Partner Agency and Valley Water would pursue a cooperative situation implemented in parallel with future development of recycled water. For example, the Project Partner(s) would develop future uses for its customers, and Valley Water would act as a wholesaler for its future non-potable and potable reuse projects. This scenario, which is similar to the relationship between Orange County Water District and Orange County Sanitation District, would involve forming a committee with shared representation and agree to cost-sharing terms related to capital costs for new facilities and annual O&M costs.

This option is likely to yield benefits to both Valley Water and the Project Partner(s). For example, Valley Water could secure water supply assurance and ROC discharge capacity and build/operate their own new recycled and/or purified water facilities. The Project Partner(s) would have authority of their own new recycled and/or purified water facilities and existing assets and may receive increased revenue from additional recycled water sales.

Joint Powers Authority (JPA)

A JPA would be established as a new governing agency with authority to construct and operate new recycled and/or purified water facilities. The JPA would manage reuse within the County (including both new and existing customers), handle regional water exchanges, and act on behalf of Valley Water and its partner(s). This scenario is similar to the arrangement for the JPA formed by Dublin-San Ramon Services District and East Bay Municipal Utility District. Referred to as DERWA, the JPA is designed to allow available recycled water from

DSRSD to be sold to EBMUD customers, share O&M costs 50/50, and conduct business by an equal representation four-member Board of Directors.

This option is likely to yield benefits to both Valley Water and the Project Partner(s). For example, Valley Water could secure water supply assurance and ROC discharge capacity and equally contribute to decisions relating to building/operating own new recycled and/or purified water facilities owned by the JPA. The Project Partner(s) would have authority of their own new recycled and/or purified water facilities and existing assets and may receive increased revenue from additional recycled water sales.

In 2016, Valley Water conducted a survey to further explore governance structures related to non-potable and potable reuse partnerships. As part of this effort, Valley Water surveyed 83 water, wastewater, irrigation, and public utilities throughout California that participate in reuse programs in roles to produce, wholesale, and/or retail recycled and/or purified water. The agencies surveyed represent a mix of municipalities, JPAs, private companies, independent public agencies, and special districts. Of the agencies surveyed, thirty-three (33) are special district water agencies, including 6 that provide both water supply and wastewater services and 27 that provide water supply services, like Valley Water.

Through the survey, Valley Water sought to collect information on industry standards with respect to the roles and procedures governing the operation of recycled and purified water programs and facilities for non-potable and potable reuse. As an outcome, Valley Water found that the roles, procedures, and policies related to delivery of recycled water for NPR are complex and vary agency to agency, while water agencies typically engage in combined roles (producer, wholesaler, and/or retailer) for potable reuse.

Valley Water identified governance models for non-potable and potable reuse programs, which involve the following roles and responsibilities of water suppliers.

- **Wholesale-only**, meaning a water supplier distributes and sells recycled or purified water to a retail water supply agency for reuse.
- **Finance-only**, indicating a water supplier (typically a water wholesaler) provides financial support for other agencies (typically water retailers) to implement reuse projects.
- **Total ownership**, meaning a water supplier participates in a single role as the producer, wholesaler, and retailer collectively.
- **Build-and-transfer model**, meaning one water supplier builds reuse facilities/infrastructure and transfers ownership to another supplier.
- **Interties between NPR systems**, meaning agencies have agreed upon policies and procedures pertaining to an intertie connecting their NPR systems.

The survey yielded several conclusions related to non-potable and potable reuse applications, summarized as follows.

Non-potable Reuse

In California, water and wastewater agencies' complementary needs—water supply augmentation (particularly dry-year reliability) and compliance with WWTP effluent discharge limitations under NPDES permits—largely drive interest and willingness to participate in partnerships.

An industry standard does not yet exist for roles, procedures, and policies related to NPR systems, leading to wide variability when comparing governance across the many partnerships.

Potable Reuse

Consistent with Valley Water's objectives in leading Countywide potable reuse planning, water supply reliability and groundwater protection against seawater intrusion have motivated other agencies throughout California to develop potable reuse systems.

Valley Water's survey results indicate an observed industry trend that water agencies primarily engage in a single role as the producer, wholesaler, and retailer collectively.

As part of implementation, Valley Water and project partners will continue to consider these models and may also explore new concepts that show promise. For example, one concept involves developing governance structures focused on increasing adaptive capacity—which is, essentially, the ability to adapt based on changing conditions—and decreasing institutional fragmentation (e.g., across sectors and governmental levels). Several governance approaches along this line include integrated water resources management, polycentricity and place-based planning, and adaptive governance.

8.5 Policy Issues

Through development of the CoRe Plan, Partner Agencies identified policy issues that require consideration and/or resolution to promote willingness and establish new long-term agreements. Three examples follow.

Equity issues related to water assurance disparities

California's system for allocating water supply has long been a source of controversy due to its complexity, ambiguity, and inequities. Some Partner Agencies have security in water assurances for meeting planned future needs even during drought, while others are currently seeking supply guarantees to support housing and commercial development. San José Municipal Water is in the latter category. Thus, an imbalance in water security would be created if moving water from a community with less-secure water assurance to a neighboring water supplier's service area (and particularly to one with more secure water rights) and would require a policy-level intervention to resolve. This issue is included as a sub-criterion in the evaluation tool.

Opportunities for water supply transfers or exchanges

A water transfer or exchange could help address the issue related to equity in water assurances, whereby the areas with less-secure water rights are given an option to purchase potable supply from the area(s) with more-secure water rights in exchange for NPR supply or reuse source water. In addition, the flexibility of RWA and TWA portfolios could be increased if supported by agreements to transfer or exchange supply among water suppliers to balance needs and supplies.

Distributed systems approach with fit-for-community reuse strategies

Interest in onsite (decentralized) NPR systems has increased among private sector companies in Silicon Valley, particularly technology providers. As summarized in Section 5.3 and described in more detail in ***Appendix A-9***, onsite reuse refers to building- or development-scale wastewater treatment and reuse of the treated stream for non-potable uses at the building or development site (e.g., irrigation, toilet-flushing, cooling tower water). The combination of this growing trend and flatline WWTP influent flows over recent years could result in competing demands for wastewater as a resource. This approach must be mindfully managed to avoid unintended impacts to centralized treatment and infrastructure, which can result in ripple effects to cost, energy, and other factors. The distributed systems approach is a regionally optimized blend of both centralized and onsite reuse. These potential impacts may be mitigated by taking a Countywide approach to optimize the blend of both onsite reuse projects and centralized reuse projects—like the portfolios considered under this CoRe Plan—to reflect local conditions in a fit-for-community strategy to identify effective ways to control costs, reduce greenhouse gas emissions, increase public awareness, and advance environmental stewardship throughout the communities in the County. Valley Water and its Partner Agencies may consider reevaluating source flow availability annually to monitor impacts and trends related to onsite reuse.

8.6 Environmental Review and Documentation

Valley Water is evaluating options to produce an Environmental Impact Report/Statement (EIR/S) that addresses National Environmental Protection Act (NEPA) and California Environmental Quality Act (CEQA) requirements and encompasses the potable reuse project portfolios/options and alternative alignments. The EIR/S will support the implementation of potable reuse and consider various alternatives.

According to CEQA Guidelines, an EIR describes impacts resulting from actions related to a project or program. The latter involves developing a programmatic EIR that acts as a foundation to support subsequently prepared individual project-level environmental documents. While a programmatic approach provides for future flexibility as needed, a project-level approach can typically be completed more quickly.

The level of effort for NEPA/CEQA is anticipated to be significant. Anticipated permitting requirements for each portfolio are included as a sub-criterion of the evaluation tool (see Section 6.5 and ***Appendix A-7)***.

8.7 Program Funding

In strategizing and planning funding to support the program's implementation, Valley Water's Board considered various alternatives and decided to use a public-private partnership approach for the North County program.

In September 2020, Valley Water's Board approved the procedures for procuring design-build-finance-operate-maintain (DBFOM) services under a public-private partnership (P3) structure. Financing through a P3 partner assumes payments begin when a facility is operational, less Valley Water's 30% share of debt financing. The total program cost to be financed depends on construction timing and duration, along with apparent factors such as facility size.

For Valley Water's share of debt financing, several public funding alternatives have been explored, as summarized below.

- **Low-interest loans,** such as those offered under Water Infrastructure Finance and Innovation Act (WIFIA), Clean Water State Revolving Fund (SRF) Loan Program, and/or Infrastructure SRF (ISRF) Loan Program
- **Grant funding,** such as programs established under Title XVI of the Reclamation Projects Authorization and Adjustment Act, Water Recycling Funding Program Construction Grants, and/or Integrated Regional Water Management Grants
- **Potential stimulus funding** based on the precedent set by the American Recovery and Reinvestment Act of 2009

Each of these alternatives has a unique set of eligibility requirements, criteria for scoring, and funding terms. For example, WIFIA favors projects that generate economic benefits and address water resource challenges, specifically pointing to groundwater recharge and water reuse, with assumed repayment of 49% of capital costs 5 years after the respective AWPF is operational.

Public financing opportunities may vary with time and specific circumstances. For example, private financing may preclude eligibility to receive funding under some public financing alternatives. The future availability of current funding programs is uncertain.

8.8 Implementation Next Steps, Opportunities, and Challenges

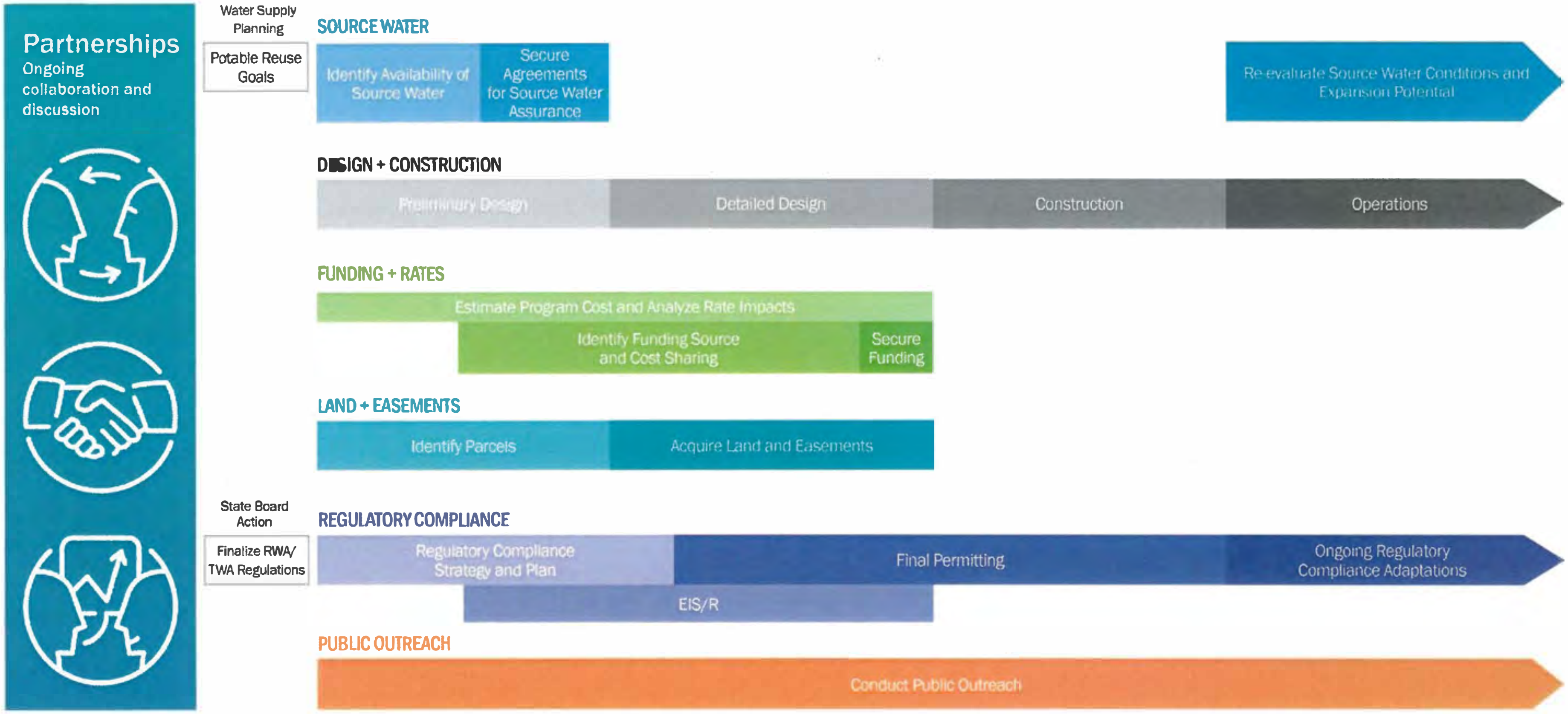
Implementing the CoRe Plan project(s) will not be a linear process. Valley Water will work with Partner Agencies on multiple implementation steps simultaneously, and the interdependency of some of those steps adds complexity. Figure 8-2 depicts a simplistic view of implementation steps within several parallel categories without indicating the complexities added by interrelationships. For example, securing source water through establishing long-term agreements is needed before proceeding with detailed design, yet program costs and other factors may influence agreement terms and conditions.

When approving the DBFOM procurement procedures, the Board also directed Valley Water staff to launch a P3 procurement plan upon sufficiently securing agreements in principle with Partner Agencies for elements necessary to implement a proposed project. Three areas requiring agreement in principle include:

- Securing long-term source water supply (treated wastewater) for development of a purified water supply for potable reuse
- Managing ROC
- Confirming the option to purchase or lease the land needed for new facilities

To manage risk, Valley Water and its partners need to consider potential challenges to implementation, such as those summarized in Table 8-3. Addressing such challenges at the earliest opportunity possible not only reduces risk but also enables greater clarity and efficiency in the path forward.

Next Steps for Implementation



Partnerships
Ongoing collaboration and discussion

Water Supply Planning

Potable Reuse Goals

State Board Action

Finalize RWA/ TWA Regulations

SOURCE WATER

Identify Availability of Source Water

Secure Agreements for Source Water Assurance

Re-evaluate Source Water Conditions and Expansion Potential

DESIGN + CONSTRUCTION

Preliminary Design

Detailed Design

Construction

Operations

FUNDING + RATES

Estimate Program Cost and Analyze Rate Impacts

Identify Funding Source and Cost Sharing

Secure Funding

LAND + EASEMENTS

Identify Parcels

Acquire Land and Easements

REGULATORY COMPLIANCE

Regulatory Compliance Strategy and Plan

Final Permitting

Ongoing Regulatory Compliance Adaptations

EIS/R

PUBLIC OUTREACH

Conduct Public Outreach

Figure 8-2. External triggers and subsequent steps for implementing Countywide reuse

Table 8-3. Implementation Challenges

Portfolio		Challenge
Portfolio 1 **San José AWPF**	1a: SJ GWR 1b: SJ RWA 1c: SJ TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline	A long-term agreement is needed between Valley Water and San José to establish a guaranteed minimum flow of sources water (SJ/SC RWF effluent) for feed flow to the AWPF. Risks to available yield include drought, environmental needs/impacts, and operations.
	1a: SJ GWR	LGRP recharge potential may limit future yield.
	1b: SJ RWA	Consistent with Valley Water's WSMP 2040 Water Evaluation and Planning modeling assumptions, DPR water is assumed to be first-priority supply for WTPs with raw water added as diluent. If this assumption changes, Penitencia WTP's capacity may limit potable reuse yield. Since the South Bay Aqueduct and Penitencia WTP are in an active landslide area, special geotechnical considerations and evaluation are needed. Depending on the findings and planned route, construction costs may increase due to special measures for addressing geotechnical concerns at this area. Capacity of Penitencia WTP could limit potable reuse yield.
	1c: SJ TWA, Milpitas Pipeline	Using the Milpitas Pipeline to convey purified water precludes independent use of an emergency connection between Valley Water's treated water system and SFPUC's Regional Water System to transfer water in emergencies. Delivering purified water to SFPUC would require inter-agency agreements and, likely, permitting each downstream delivery point (i.e., each water supplier that could access the supply in the downstream portion of the RWS). Details regarding potential terms for inter-agency agreements and DDW permits would need to be explored and established to further pursue this concept. Blending ratios of purified water with other supplies need to be confirmed. Using the Milpitas Pipeline for purified water conveyance may result in delivering high ratios of purified water to several turnouts along the Milpitas Pipeline.
	1c: SJ TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline	An evaluation is needed to confirm sufficient space for a tie-in at Piedmont valve yard. Because Gibraltar pump station belongs to the City of Milpitas, a separate agreement would be needed to use their reservoirs as blending facility, and reservoir storage capacities would need to be verified for future blending. (1c, 1d).
Morgan Hill **MH-1: NPR+**		A long-term agreement is needed to secure source water. The Silver Creek Pipeline Agreement granting 5 mgd of SBWR supply to Valley Water via the Silver Creek Pipeline expires in January 2027. Without a renewed agreement, MH-1 (NPR+) would be infeasible. Potential impacts of NPR/NPR+ irrigation to the quality of groundwater in the northern portion of the Llagas Subbasin are currently undetermined and warrant further study. Given shifting development trends in Morgan Hill, an updated NPR market assessment is needed.
Portfolio 2 **Combined Palo Alto/Sunnyvale regional AWPF located in either:** **Palo Alto (2a), or** **Sunnyvale (2b)**	2a: PA (+SV) GWR 2b: SV (+PA) GWR	Flows from Palo Alto RWQCP and Sunnyvale WPCP limit projected yield. A long-term agreement is needed between Valley Water and Sunnyvale to establish a guaranteed minimum flow of source water (WPCP effluent) for feed flow to the AWPF. ROC management permitting and regulatory compliance need to be confirmed.
	2b: SV (+PA) GWR	ROC management options are limited and less feasible compared to other reuse opportunities and AWPF locations. Technical feasibility and extent of costs related to site preparation to construct an AWPF at the parcel next to Sunnyvale's WPCP, Recycle Hill (a former landfill site), remain in question. Due to lack of available land, Recycle Hill is the site assumed for preliminary design purposes, and best available information is included to reflect potential site preparation costs.
Portfolio 4 **Separate regional AWPFs located in Palo Alto and Sunnyvale**	4: PA/SV GWR	Flows from Palo Alto RWQCP and Sunnyvale WPCP limit projected yield. A long-term agreement is needed between Valley Water and Sunnyvale to establish a guaranteed minimum flow of source water (WPCP effluent) for feed flow to the AWPF. Constructing and operating two separate AWPFs is estimated to be the highest cost portfolio. ROC management options are limited and less feasible compared to other reuse opportunities and AWPF locations. Permitting and regulatory compliance for ROC management need to be confirmed. Costs do not reflect land for AWPF site in Palo Alto. Due to lack of available land, Recycle Hill (the former landfill site by the WPCP) is assumed for preliminary design purposes. Technical feasibility and costs of constructing at this site remain uncertain. Best available information is included to reflect potential site preparation costs.
Morgan Hill **MH-2: GWR and MH-3: SWA**	MH-2: GWR MH-3: SWA	ROC management at lined evaporation ponds may be ruled infeasible during environmental review. Morgan Hill satellite facility would increase solids loads to SCRWA, posing operational issues that may be substantial. If implemented in Morgan Hill, solids handling requires further study and may increase costs significantly.
	MH-2: GWR	If further study of Morgan Hill recharge locations does not identify a suitable location, implementation of MH-2 (GWR) would be infeasible.
	MH-3: SWA	Additional evaluation is needed to confirm feasibility of water exchange without additional recharge facilities. Details around the conditions and reliability of increasing Valley Water's raw water deliveries to Llagas Subbasin remain unconfirmed. As in MH-2 (GWR), a suitable recharge location is needed. New permits may be required through the SF Bay or Central Coast Regional Board, or DDW, for discharging purified water to Anderson Reservoir.

To implement a water reuse program within the County, Valley Water will work closely with its Board of Directors, including Recycled Water Committee members, and Partner Agencies to take the following steps, many of which are interdependent and are not listed sequentially.

✓ Initiate Countywide collaborative potable reuse **public outreach and engagement** informed by portfolios to be implemented, planned project locations, and rate impacts.

✓ Start **environmental review** at the end of preliminary design and, following certification of the final EIR/S, proceed with selecting a P3 partner and permitting.

✓ Continue to refine **regulatory compliance** strategy as reuse opportunities take shape and new DPR regulations are established. Seek Regional Board buy-in on ROC management.

✓ Refine **reuse goals** based on pending updates to water demand projections. Confirm minimum available **source water** to secure partnership agreement(s) and achieve goals. Resolve **policy issues** and define governance structure.

✓ Execute **long-term agreements** for source water and confirm project portfolios and alternative elements for implementation based on partnership agreements.

✓ Acquire **land and/or easements** for reuse program/projects and identify roles and responsibilities for site preparation.

✓ Secure **program funding** and refine resulting **rate impacts**.

✓ Prepare **refined designs** to right-size projects based on available flows.

✓ Continue advancing **ROC management** strategies.

Section 9:
Flexible Implementation Scenarios

As directed by the Board, Valley Water is implementing a purified water project that will align near-term source water availability from one its partners with updated water supply needs. As part of this near-term project, Valley Water is currently investigating a flexible implementation ("Flex") approach that can support potential reuse expansion in the future. The term flexible implementation refers to a prudent planning approach for designing and constructing a near-term GWR project (anticipated by 2028) with sufficient flexibility to support potential future increases to treatment facility hydraulic capacity and purified water deliveries, opportunities associated with development of DPR regulations, and treatment process enhancements as applicable based on reuse type.

9.1 Context

At the Board's direction, Valley Water is advancing plans to construct an AWPF with a production capacity of 10 mgd for GWR to yield about 11,000 AFY of supply. The near-term project involves design and construction of a pipeline to convey purified water from an AWPF in the North County to the LGRP system for GWR via surface spreading. The purpose of using a flexible implementation approach is to consider design aspects at the outset that can support potential future expansion of the 10 mgd facility by increasing the production capacity for a total capacity of up to 24 mgd. Three scenarios for the flexible expansion from a 10-mgd near-term project to 24 mgd are considered: GWR Flex, RWA Flex, and TWA Flex (Figure 9-1).

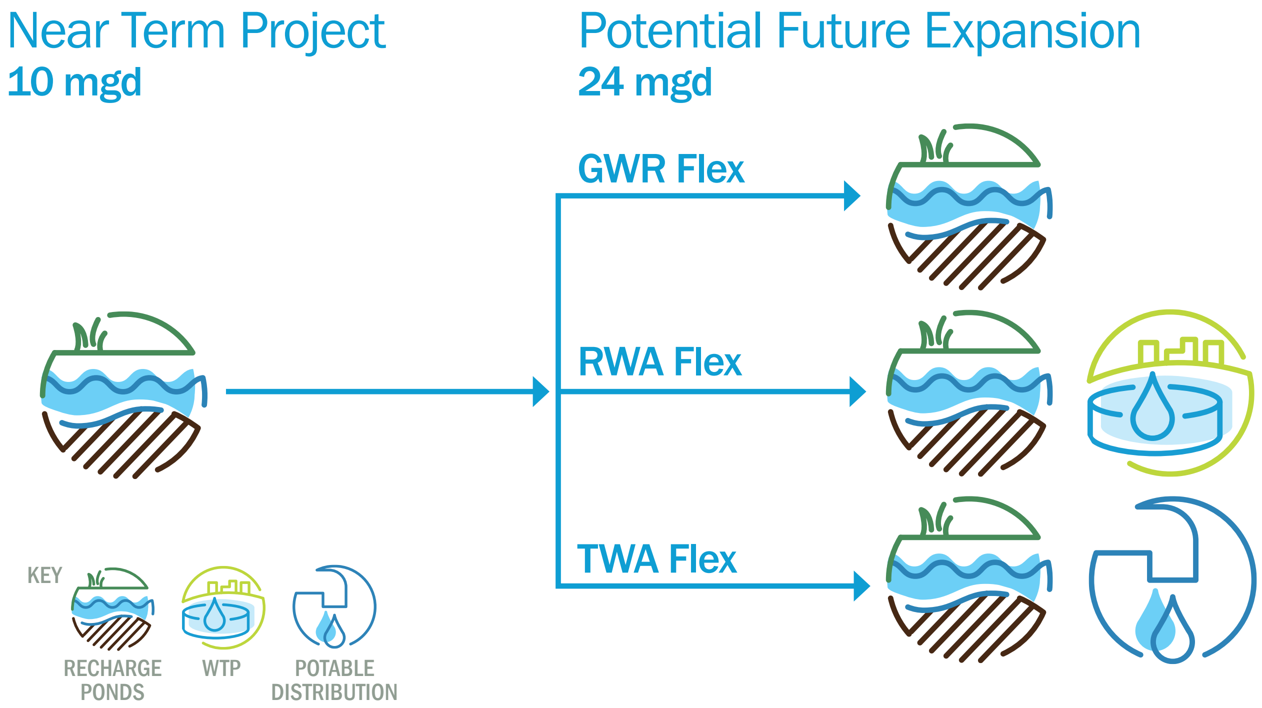


Figure 9-1. Conceptual overview of flexible implementation scenarios

Each flexible expansion scenario considered in this analysis is assumed to increase capacity of the 10 mgd AWPF to 24 mgd and treat the full extent of flow to the highest quality required by the delivery points (reuse type). For example, TWA Flex would treat all flow from the 24 mgd facility to TWA quality, even though part of the flow would be delivered to LGRP. Potential future expansion is critically linked to the following aspects of the near-term project:

- Pipelines to convey 24 mgd of purified water from the AWPF to LGRP. While the portfolios include 48-inch pipe diameter for conveyance, the Flex scenarios reduce that to 36-inch, which allows for conveyance of the full 24 mgd in the future.
- ROC management facilities
- Site layout and footprint for a 24 mgd capacity AWPF with sufficient space for the respective treatment processes, process building footprint, and facilities to meet requirements of anticipated reuse types. That is, to implement either RWA Flex or TWA Flex in the future, treatment is anticipated to require additional processes for the full 24 mgd regardless of amount used for GWR at any given time. In addition, the site layout requires sufficient space to considering the turning radius of trucks that require site access for activities such as chemical deliveries, emergency services, and construction of the expanded facility.
- Land acquisition and site preparation to accommodate the 24 mgd AWPF's site layout and footprint

It is assumed that the AWPF would shut down during construction to expand the facility and that membranes from the near-term project are feasible for continued use (as their life cycle allows) in a future RWA or TWA application.

While the near-term project is definitively GWR, various conditions, events, or processes may trigger, or hinder, future expansion to GWR, RWA, or TWA Flex, such as reliability of other water supplies[1]; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand. Flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities.

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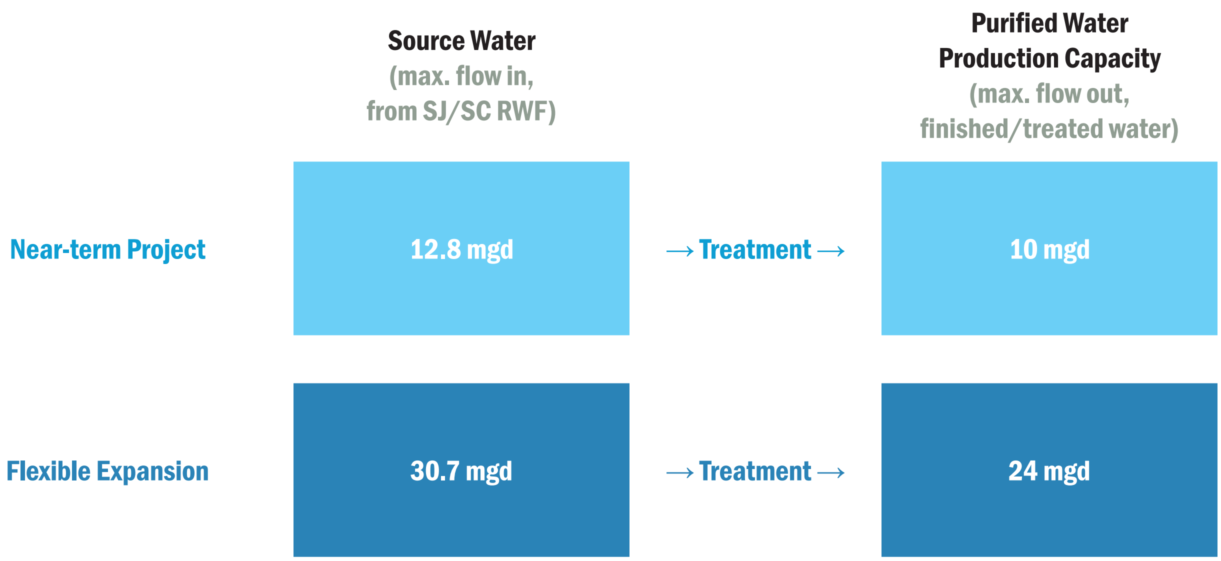
[1] Factors that influence supply reliability may include, but are not limited to, water supply agreements/contracts, hydrologic conditions (i.e., droughts, climate change), evolving and new regulations, natural disasters (e.g., earthquakes, wildfires), and/or human-induced threats.

9.2 San José Flex Scenarios

Flexible implementation scenarios are considered using a San José-based AWPF and a Palo Alto-based AWPF. San José Flex scenarios are premised on treating effluent from the SJ/SC RWF at a new AWPF located in San José at a site adjacent to the existing Silicon Valley Advanced Water Purification Center (SVAWPC). The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd. Figure 9-2 summarizes treatment capacity assumptions for the near-term project and flexible expansion (GWR, RWA, and TWA Flex scenarios).



	Source Water (max. flow in, from SJ/SC RWF)		**Purified Water Production Capacity** (max. flow out, finished/treated water)
Near-term Project	12.8 mgd	→ Treatment →	10 mgd
Flexible Expansion	30.7 mgd	→ Treatment →	24 mgd

Figure 9-2. Assumed source water flow rates and production capacities for flex implementation of a San José-based AWPF

Process flow diagrams and site layouts for near-term and flexible expansion capacities are included in ***Appendix A-10.*** The proposed pipeline alignments for San José RWA and TWA Flex are shown in Figures 9-3 and 9-4. GWR Flex alignments are consistent with alignments shown in Portfolio 1a (SJ GWR), although the purified water pipeline diameter is 36 inches instead of 48 inches.

GWR

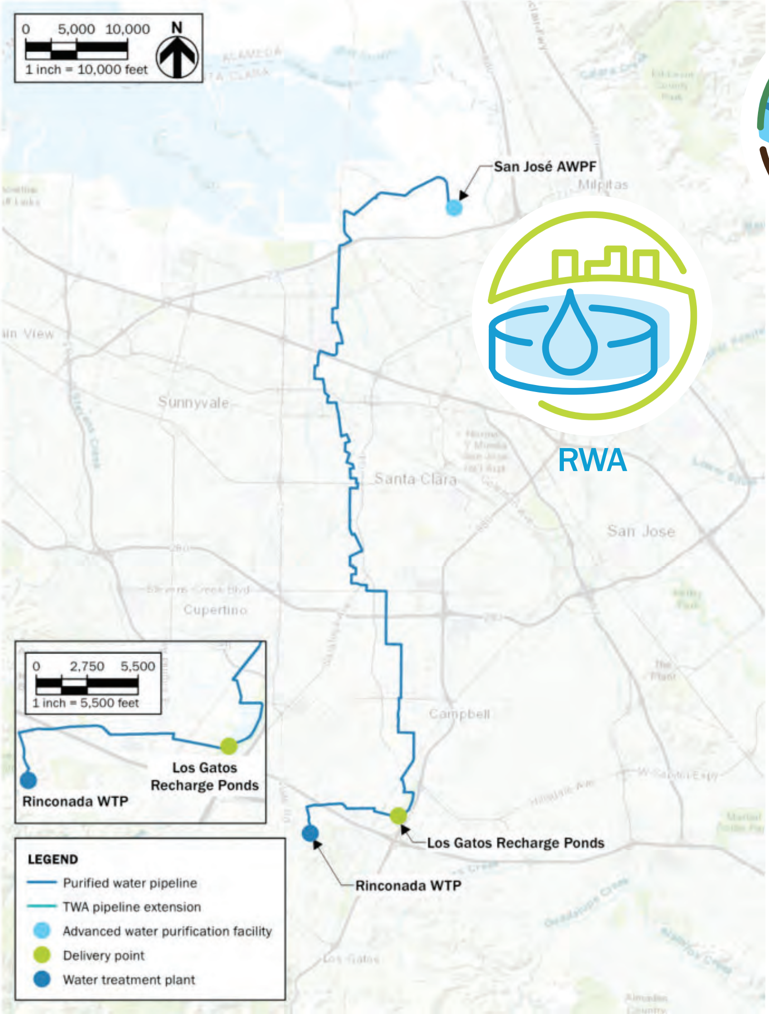


Figure 9-3. Flexible implementation from San José-based AWPF: RWA Flex facility locations and pipeline alignments

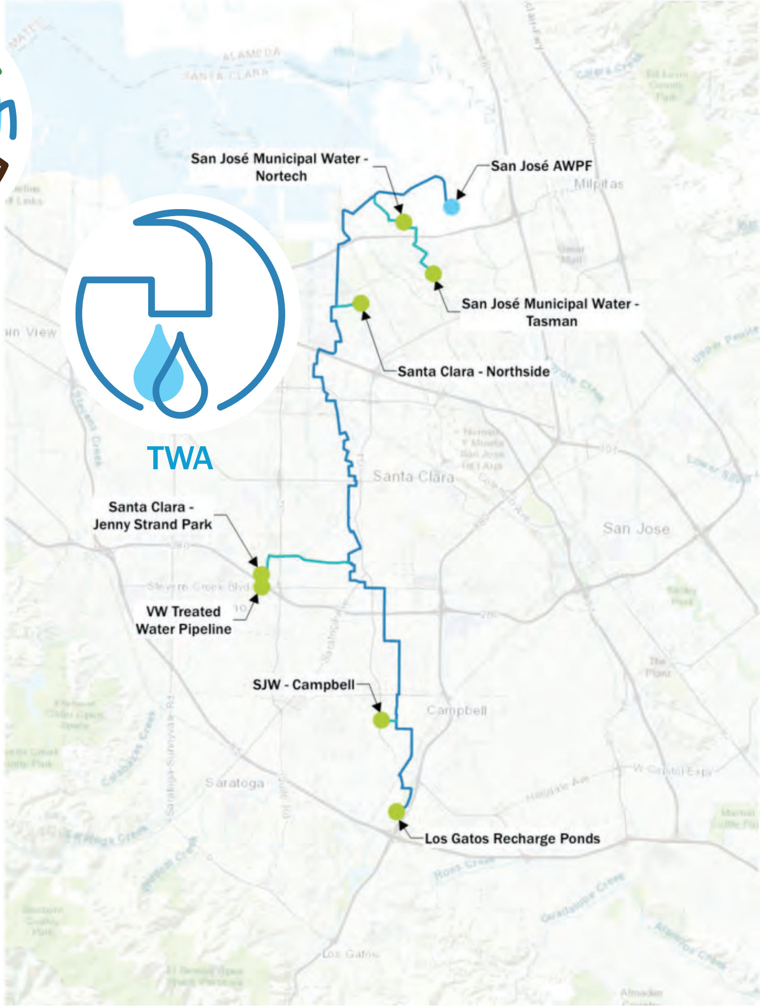

San José Municipal Water - Nortech
San José AWPF
San José Municipal Water - Tasman
Santa Clara - Northside
TWA
Santa Clara - Jenny Strand Park
VW Treated Water Pipeline
SJW - Campbell
Los Gatos Recharge Ponds
Santa Clara
San Jose
Campbell
Saratoga
Milpitas

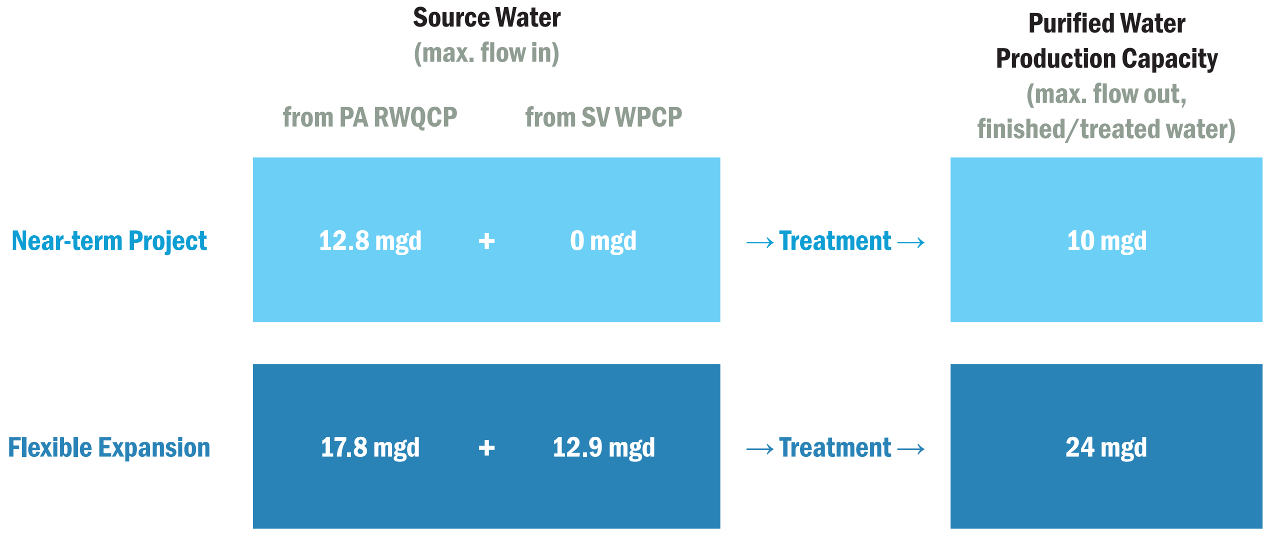
Figure 9-4. Flexible implementation from San José-based AWPF: TWA Flex facility locations and pipeline alignments

Note: GWR Flex map is consistent with Figure 6-1 (Portfolio 1a: SJ GWR)

9.3 Palo Alto Flex Scenarios

Palo Alto Flex scenarios are premised on treating available effluent from the Palo Alto RWQCP, and from Sunnyvale WPCP if AWPF is expanded in the future, with a new AWPF located at the former LATP site. Source water for the near-term project would be supplied only by the Palo Alto RWQCP. The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd. A source water pipeline would be constructed between the Palo Alto RWQCP and LATP site, sized to accommodate source water necessary for the future flexible expansion (17.8 mgd to produce 14 mgd of purified water). A source water pipeline from the Sunnyvale WPCP to the LATP site would only be constructed as part of the future expansion.

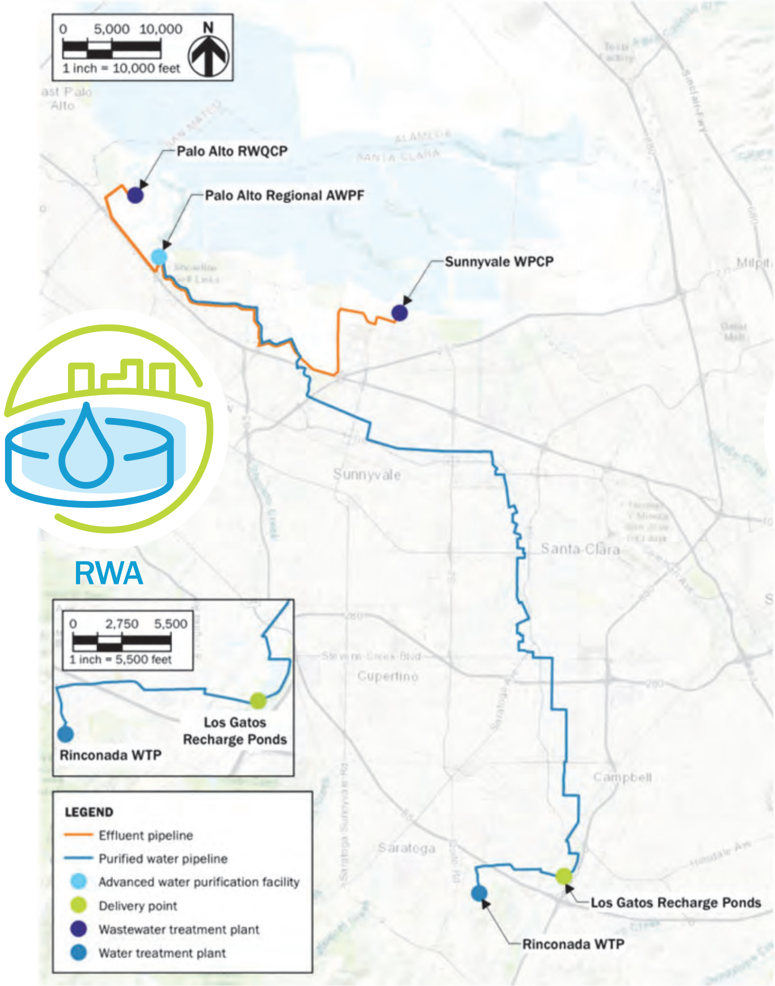
Figure 9-5 summarizes treatment capacity assumptions for the near-term project and flexible expansion (GWR, RWA, and TWA Flex scenarios).



	Source Water (max. flow in) from PA RWQCP		Source Water (max. flow in) from SV WPCP		Purified Water Production Capacity (max. flow out, finished/treated water)
Near-term Project	12.8 mgd	+	0 mgd	→ Treatment →	10 mgd
Flexible Expansion	17.8 mgd	+	12.9 mgd	→ Treatment →	24 mgd

Figure 9-5. Assumed source water flow rates and production capacities for flex implementation of a Palo Alto-based AWPF

Process flow diagrams and site layouts for near-term and flexible expansion capacities are included in ***Appendix A-11***. The proposed pipeline alignments for Palo Alto RWA Flex and TWA Flex are shown in Figures 9-6 and 9-7. GWR Flex alignments are consistent with alignments shown in Portfolio 2a (PA [+SV] GWR), although the purified water pipeline diameter is 36 inches instead of 48 inches.



RWA

GWR

TWA

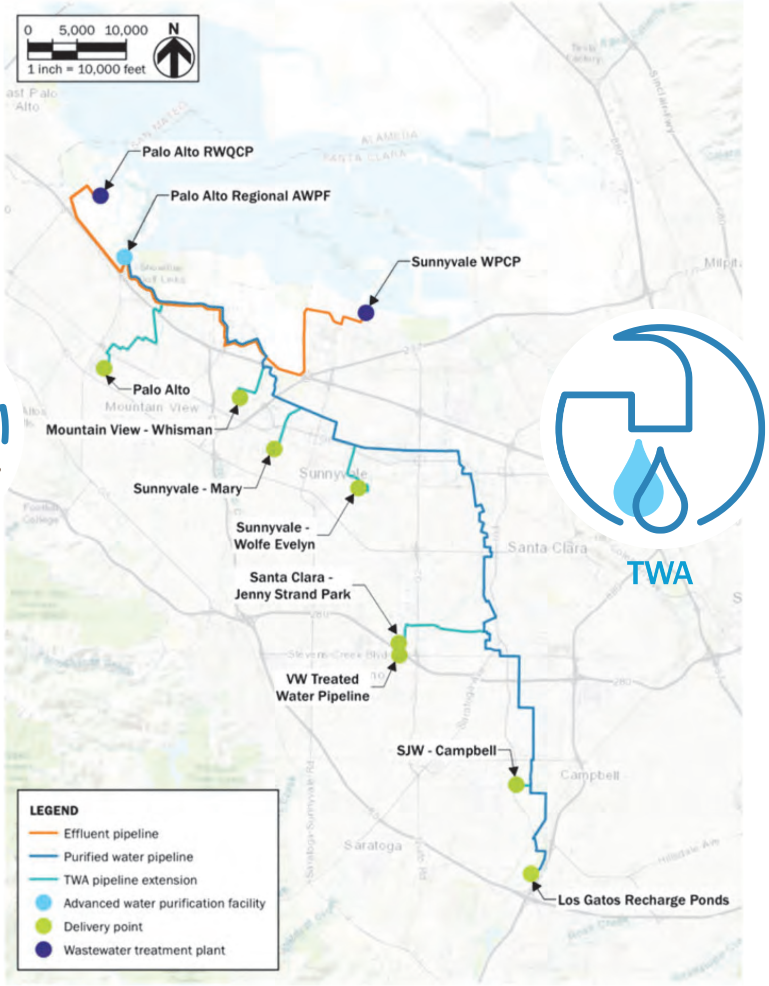


Figure 9-6. Flexible implementation from San José-based AWPF: RWA Flex facility locations and pipeline alignments

Figure 9-7. Flexible implementation from San José-based AWPF: TWA Flex facility locations and pipeline alignments

Note: GWR Flex map is consistent with Figure 6-2 (Portfolio 2a: PA (+SV) GWR)

9.4 Flex Scenario Costs

Estimated capital and annual operations and maintenance (O&M) costs for flex scenarios are presented in graphical form in Figure 9-8. Further cost details are included in ***Appendices A-10*** and ***A-11****.*

The estimated unit cost for the San José GWR Flex near-term 10 mgd project over 30-year and 100-year life cycles would be $3,300/AF and $2,600/AF, respectively, and $3,600/AF and $2,700/AF, respectively, for Palo Alto GWR Flex. This estimate includes capital, O&M, renewal and replacement, and source water purchase and does not include future flex expansion as part of the life cycle. The purified water pipeline to LGRP is sized at 36-inches for the near-term project to accommodate potential future expansion to 24 mgd. CoRe Plan portfolios use a 48-inch purified water pipeline to LGRP.

San José and Palo Alto Flex scenario cost differences of note include:

- AWPF capital costs for all Palo Alto Flex scenarios are lower than for the equivalent San José AWPFs. The Palo Alto AWPF has a smaller site, translating to a smaller process building. The process building cost was based on area, making Palo Alto's process building less expensive than that of San José. Higher AWPF cost for San José was then magnified compared to Palo Alto's after applying contingencies and cost multipliers, then rounding to the nearest $5M.
- Conveyance costs for Palo Alto are higher due to long effluent pipelines between the Palo Alto RWQCP and Palo Alto AWPF for the near-term project, and between the Sunnyvale WPCP and Palo Alto AWPF for the Flex scenarios. The San José scenarios have a 60-inch effluent pipeline that is 0.4-mile long, whereas the 36-inch Palo Alto effluent pipeline is 2.9 miles long and 36-inch Sunnyvale effluent pipeline is 7.4 miles long.

Costs are likely to change as designs are refined.

For additional detail, refer to the following:

- Methodology for estimating life-cycle costs: Refer to ***Appendix A-5***
- Cost tables for conveyance infrastructure that is a consistent size in the CoRe Plan and this Flex TM: Refer to ***Appendix A-6***
- Tables with life-cycle cost details: See Table B-16 in ***Appendix A-10*** or ***Appendix A-11***

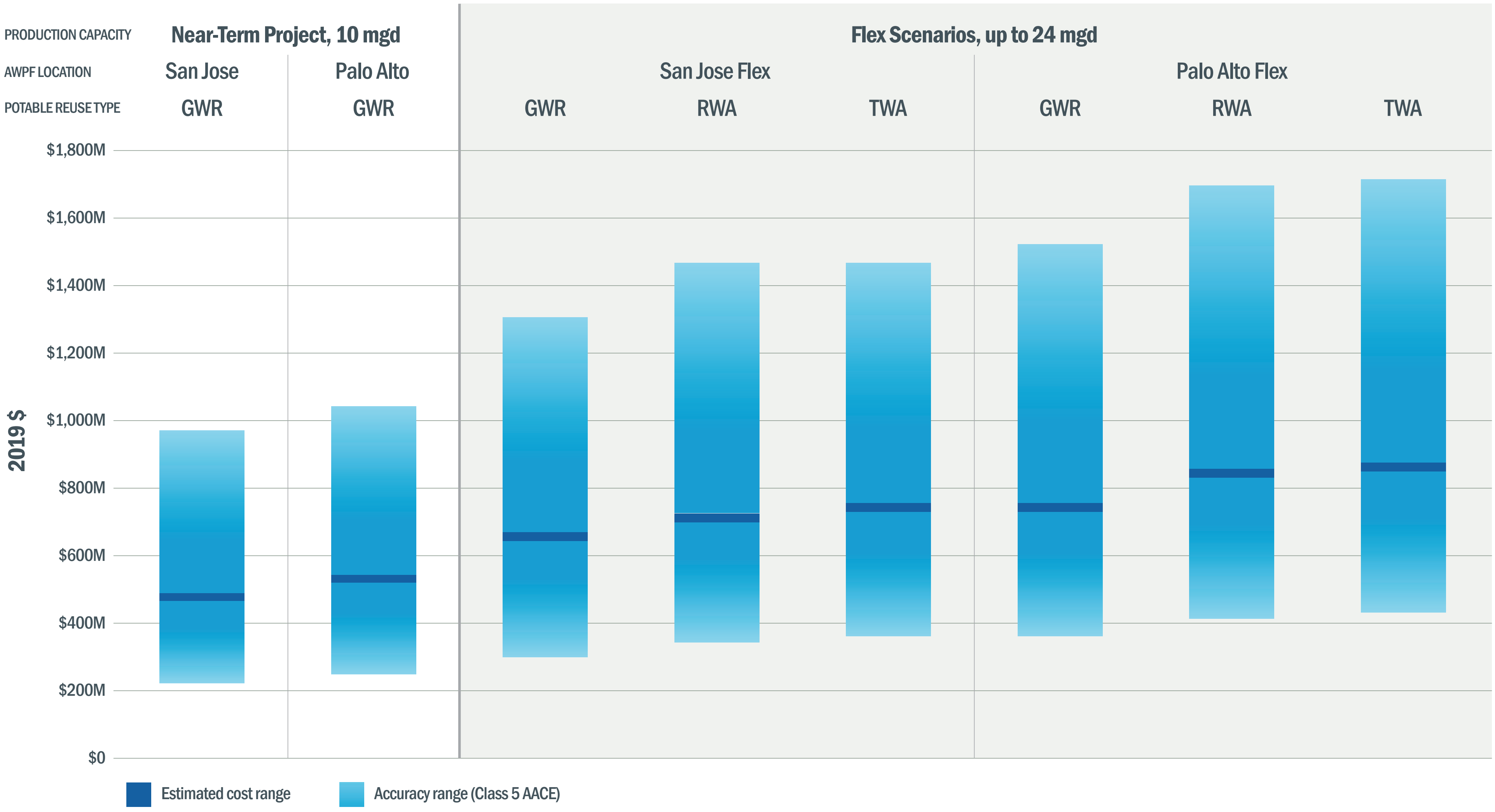


Figure 9-8. Estimated capital costs of flexible implementation scenarios

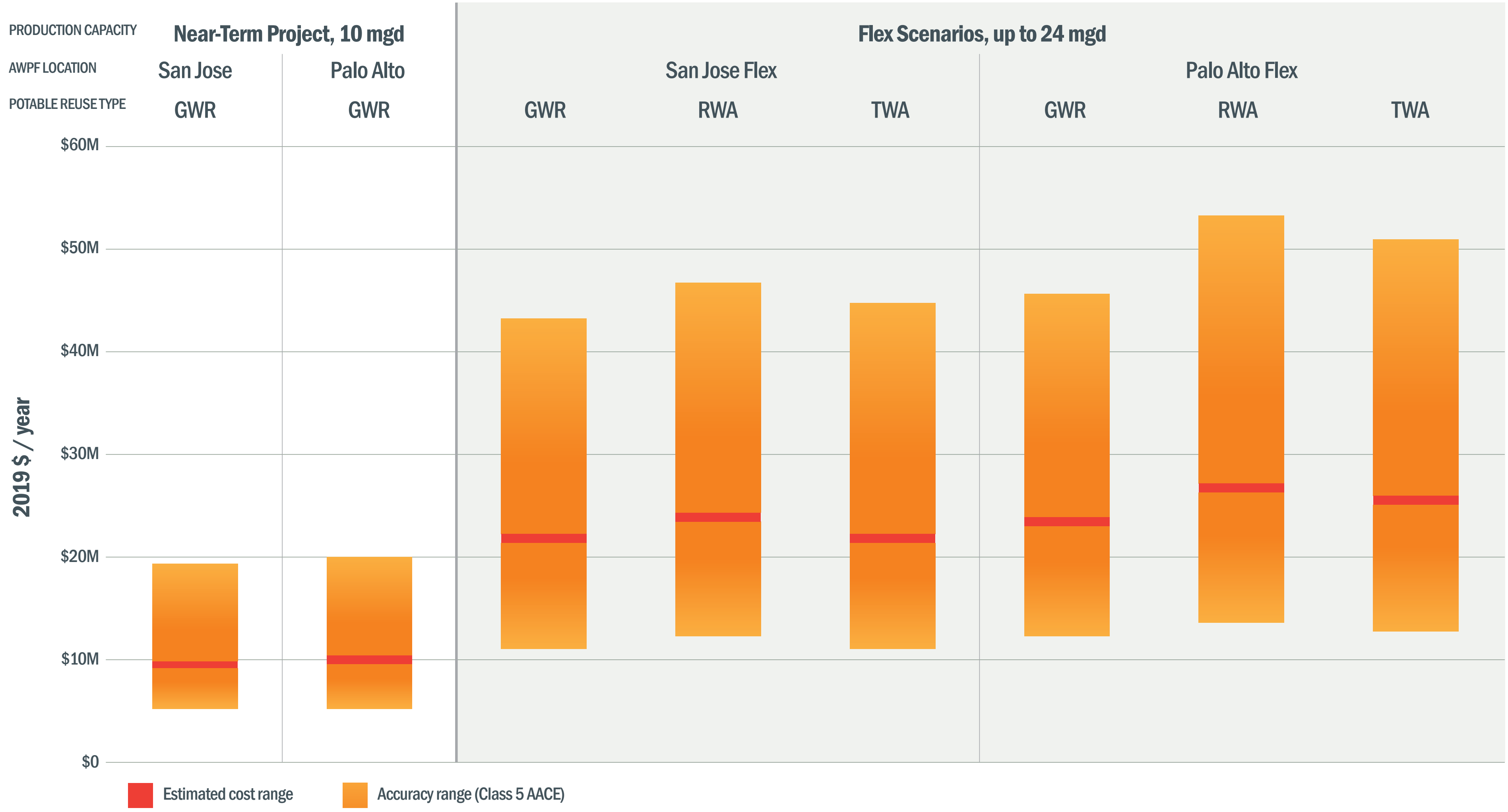


Figure 9-9. Estimated O&M costs of flexible implementation scenarios

9.5 Pipeline Sizing Cost Evaluation

The project team conducted a high-level sensitivity evaluation to determine the cost impact of conveyance based on changing diameter of the purified water pipeline from the AWPF to LGRP. The evaluation uses Portfolios 1a and 2a (SJ GWR and PA [+SV] GWR) costs as a basis and modifies conveyance sizing and costs based on an assumed diameter for the pipeline delivering purified water to LGRP. This evaluation does not include the costs of pipelines to deliver TWA via potable distribution systems or RWA via Rinconada WTP.

Five pipeline sizes (diameters) are presented in Table 9-1 and summarized as follows:

1. The first option is consistent with CoRe Plan Portfolios 1a and 2a (SJ GWR and PA [+SV] GWR) and consists of a 48-inch pipeline capable of conveying up to 40 mgd of purified water flow to LGRP.
2. The second option is consistent with scenarios in this Flex TM and consists of a 36-inch pipeline to LGRP capable of conveying up to 24 mgd of purified water.
3. The third option is a pipeline with varying diameter that allows Valley Water and its Partners to have up to 10 mgd of capacity available for GWR or RWA and up to 24 mgd of capacity available for TWA. A variable diameter pipeline could save capital cost while still delivering up to 24 mgd of purified water. For San José flex, the tapered diameter pipeline option starts as a 36-inch pipeline, reduces to a 30-inch pipeline following a large turnout at Levi's Stadium and Santa Clara's Northside Tanks, then reduces again to a 24-inch pipeline following another large turnout at Santa Clara's Serra/Jenny Strand Park tanks. For Palo Alto flex, the variable diameter pipeline starts out as a 36-inch pipeline, then reduces to a 24-inch pipeline following a large turnout at Santa Clara's Serra/Jenny Strand Park tanks. The large turnouts are locations where purified water could be delivered for TWA.
4. The fourth pipeline size evaluated is a 30-inch pipeline to LGRP to deliver up to 16 mgd—which results in saving capital cost but limits future opportunities to deliver additional purified water.
5. The fifth pipeline size evaluated is a 24-inch pipeline to LGRP to deliver up to 10 mgd—which results in saving capital cost but limits future opportunities to deliver additional purified water.

These pipeline options and turnouts require additional study to confirm engineering feasibility and are included to conceptually define order-of-magnitude cost savings of reducing pipeline diameters. Cost details of each option are shown in Attachment C of ***Appendices A-10*** and ***A-11.***

Table 9-1. Estimated Conveyance Costs under Various Scenarios for Purified Water Pipeline Diameter from AWPFs in San José or Palo Alto to LGRP

Purified Water Pipeline Diameter (in)	Conveyance Capacity for AWPF Buildout (mgd)		Conveyance Costs ($M)				Notes
			From San José AWPF		From Palo Alto AWPF		
	TWA	GWR or RWA	Capital	Annual O&M	Capital	Annual O&M	
48”	Up to 40		$320	$3.4			From San José AWPF: Reflects CoRe Plan Portfolio 1a (SJ GWR) for 24 mgd, as originally conceived in SBWR Strategic Plan and considered in the Purified Water Program Plan (i.e., sized for future expansion, up to 40 mgd).
					$445	$5.1	From Palo Alto AWPF: Reflects CoRe Plan Portfolio 2a (PA [+SV] GWR) for 24 mgd, using comparable sizing assumptions as the similar Portfolio 1a (SJ GWR).
36”	Up to 24		$245	$3.4			Reflects option included in each respective Flex Implementation TM (for near-term project and potential future expansion), included as Appendices A-10 and A-11.
					$375	$5.1	
Variable/ graduated	Up to 14 for TWA	Up to 10 for GWR or RWA	$210	$3.4			Assumes up to 24 mgd of purified water, with 14 mgd for TWA and 10 mgd for GWR or RWA. Costs shown do not include pipelines to deliver TWA (via potable distribution) or RWA (via Rinconada WTP). Reduces purified water pipeline diameter from north to south: • For pipeline from San José AWPF: diameter reduces from 36” to 30” to 24” • For pipeline from Palo Alto AWPF: diameter reduces from 36” to 24”
					$355	$5.2	
30”	Up to 16		$210	$2.4			Sized to deliver 16 mgd to any point along the purified water pipeline; delivering more than 16 mgd requires a parallel pipeline and/or pump station. • For San José AWPF: Requires same level of capital investment as graduated pipelines but supports less capacity and yield. • For Palo Alto AWPF: Assumes source water from Palo Alto (12 mgd) and Sunnyvale (8 mgd) to produce 16 mgd of purified water.
					$305	$3.6	
24”	Up to 10		$165	$1.7			Sized to deliver 10 mgd to any point along the purified water pipeline; delivering more than 10 mgd requires a parallel pipeline and/or pump station. • For Palo Alto AWPF, assumes source water from Palo Alto.
					$215	$2.5	

[a] Unless otherwise noted, general design criteria apply as follows: minimum pressure = 25 psi; pipe head loss <10 feet per 1,000 LF of pipe; pipe velocity <7 fps (generally 5-7 fps); Hazen-Williams coefficient (C) = 130, ductile iron pipe; efficiency = 65%; and safety factor = 10%. Design capacity of portfolio pump stations is included in Appendix A-5 along with cost assumptions for conveyance and other elements.

[b] Attachment C to Appendices A-10 and A-11 includes cost breakdown of pipeline size options.

[c] Assumes that pipeline easement cost is $32/foot.

[d] Costs are rounded up to the nearest $5M for capital and $0.1M for O&M. Difference in annual O&M due to reduced pipeline diameter is expected to be minimal.

9.6 Considerations for Next Steps

VW's Board has directed staff to proceed with the design and construction of a near-term potable reuse project for a 10 mgd AWPF to yield approximately 11,000 AFY using a public-private partnership (P3) delivery method. Flexible implementation scenarios offer a prudent planning approach to meeting the Board directive, while leaving a pathway to expand purified water use in the County in the future.

Flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities. Although implementation of flex scenarios is not certain, factors that may influence a future expansion include reliability of other water supplies; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand.

Implementing a potable reuse project at San José is pending execution of agreements to define cost sharing, source water quantity and quality requirements, operational responsibilities, and other items. Valley Water and San José navigated similar issues in 2010 when negotiating the Recycled Water Facilities and Programs Integration Agreement for the existing 8-mgd SVAWPC. In 2019, Valley Water and Palo Alto executed a cost sharing and supply agreement to secure 9 mgd of effluent from Palo Alto. These past agreements provide a useful precedent for informing and guiding partnerships now and into the future.

Implementing a potable reuse project at Palo Alto is supported by the 2019 agreement between VW and Palo Alto committing a minimum average effluent volume of 9 mgd from Palo Alto's RWQCP to VW at a cost of ~$100/AF to supply a regional AWPF.

Next steps for implementation will be covered as part of the P3 project.

Section 10:
Appendices List

Appendices are compiled in a separate file and include the following (ordered by relevance/importance).

Appendix A: Feasible Project Portfolios

Appendix A-1: Feasible Project Portfolios TM

Appendix A-2: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield

Appendix A-3: Design Criteria

Appendix A-4: Preliminary Project Designs

Appendix A-5: Basis of Cost

Appendix A-6: Cost Estimates

Appendix A-7: Evaluation and Risk Assessment Tool

Appendix A-8: Treated Water Augmentation Pre-Screening Analysis

Appendix A-9: Onsite Reuse TM

Appendix A-10: San José Flex Implementation TM

Appendix A-11: Palo Alto Flex Implementation TM

Appendix B: Regulatory Compliance

Appendix B-1: Regulatory Compliance Strategy TM

Appendix B-2: Regulatory Framework TM

Appendix C: Hydraulic Modeling

Appendix C-1: Modeling Plan and Results

Appendix C-2: SBWR System Master Plan Updates TM

Appendix D: Project Definition, Roles, and Responsibilities

Appendix D-1: Project Definition, Roles, and Responsibilities

Appendix E: Baseline Analysis

Appendix E-1: Baseline Analysis

Appendix E-2: Recycle Hill Geotechnical Preliminary Study

Appendix E-3: Recycle Hill Geotechnical and Geo-environmental Exploration Plan

Appendix F: Conceptual Alternatives

Appendix F-1: Conceptual Alternatives

Appendix G: ROC Management Strategies Reference Files

Section 11:
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Glossary

The following definitions are established for use within this Countywide Water Reuse Master Plan (CoRe Plan). While many terms listed here are industry standard[1], several are specific to Valley Water or this plan.

Foundational Terms

- **CoRe Plan** refers to the Countywide Water Reuse Master Plan developed by Valley Water and its Project Team in coordination with its Project Partners.
- **Potable Water** is drinking water that meets or exceeds state and federal drinking water standards.
- **Non-potable Water** is water not fit for human consumption.
- **Recycled Water**, or sometimes called "purple pipe" due the distinguishing color of infrastructure reserved for its conveyance and distribution, generally refers to treated domestic wastewater used more than once before passing back into the natural water cycle. While the terms water reuse and recycled water are used interchangeably in some settings, for the purpose of this CoRe Plan, the term recycled water indicates non-potable reuse.
- **Reuse, or Water Reuse**, applies to both non-potable reuse (recycled water) and potable reuse, further described below.

Water Reuse Types

- **Non-potable Reuse (NPR)** refers to recycled water that is not used for drinking, but is safe to use for irrigation, industrial uses, or other non-drinking water purposes.
  - **Enhanced NPR, or NPR+**, is recycled water for non-potable reuse that has been blended with purified water to reduce concentration of salts and other dissolved solids to enable broader application of recycled water for non-potable end uses and protect groundwater quality.
- **Potable Reuse** refers to recycled water sufficiently purified through advanced treatment to meet or exceed federal and state drinking water standards and is safe for human consumption. Potable reuse takes one of two forms: indirect or direct potable reuse.
  - **Indirect Potable Reuse (IPR)** involves blending purified water with water supply in an environmental system, such as a surface water reservoir or groundwater basin, that acts as a buffer for retaining and diluting the reuse supply before treating the blended supply.[2] IPR can be accomplished through groundwater recharge or surface water augmentation.
    - **Groundwater Recharge (GWR)**, as defined in context of IPR, is a process that involves using constructed facilities that spread water across infiltration basins or percolation ponds (surface spreading),) or pump water directly into the subsurface through injection wells (subsurface injection) to increase water supply in a groundwater aquifer (natural underground water storage).
    - **Surface Water Augmentation (SWA)** involves adding purified water to a surface water reservoir to increase water supply.

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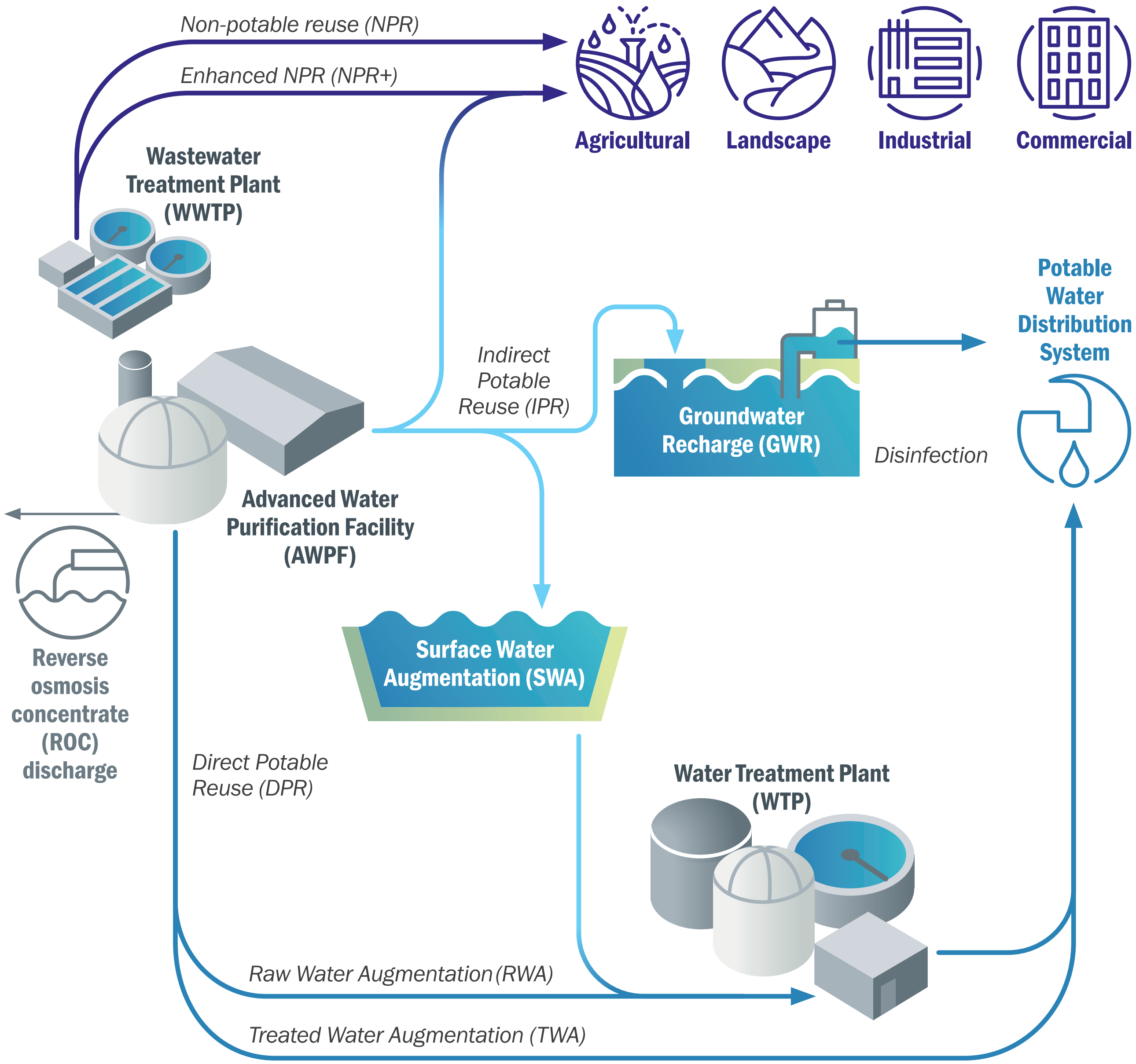
[1] Many definitions listed here are based on the Water Reuse Terminology summary (June 2016) posted on WateReuse Association's website and developed by WateReuse California, Association of California Water Agencies, and California Association of Sanitation Agencies. https://watereuse.org/educate/water-reuse-101/glossary/

[2] Local groundwater is disinfected, while surface water goes through conventional treatment (including disinfection).

- **Direct Potable Reuse (DPR)** involves the treatment and distribution of purified water using engineering controls, without an environmental buffer, in the form of raw water augmentation or treated water augmentation.
    - **Raw Water Augmentation (RWA)** involves blending purified water with other supplies immediately upstream of a water treatment plant.
        - **Treated Water Augmentation (TWA)** involves introducing purified water directly into a potable (drinking) water distribution system downstream of a water treatment plant.

Types of Reuse


Non-potable reuse (NPR)
Enhanced NPR (NPR+)
Agricultural
Landscape
Industrial
Commercial
Wastewater Treatment Plant (WWTP)
Indirect Potable Reuse (IPR)
Groundwater Recharge (GWR)
Disinfection
Potable Water Distribution System
Advanced Water Purification Facility (AWPF)
Reverse osmosis concentrate (ROC) discharge
Surface Water Augmentation (SWA)
Direct Potable Reuse (DPR)
Water Treatment Plant (WTP)
Raw Water Augmentation (RWA)
Treated Water Augmentation (TWA)

Visual Glossary-1. Types of reuse explored for Valley Water's CoRe Plan

Water Uses and Delivery Methods

- **Augmentation** is the process of adding recycled or purified water into an existing raw water supply (such as a reservoir, lake, river, wetland, and/or groundwater basin).
- **Beneficial Reuse** is the use of recycled water for purposes that contribute to the water needs of the economy and/or environment of a community.
- **Delivery Points are locations where treated water would be conveyed for reuse (NPR or PR).**
- **Environmental Flow/Benefit** is water quantity, timing, and quality to sustain ecosystems/ habitats/ natural systems.
- **Irrigation** is the physical application of water to land to assist in the production of crops or landscape.
- **Retrofit** is the process of constructing and separating potable and recycled water pipelines that allows recycled water to be used for non-potable purposes. This also includes the process of preparing customer use sites for recycled water use.
- **Percolation Ponds** (also known as **Recharge Ponds or Spreading Basins**) are constructed facilities where water is delivered and allowed to seep through the ground surface, naturally filtering underground and replenishing groundwater supply in deep **aquifers** (i.e., underground reservoirs, also referred to as **groundwater basins**).

Water Types and Quantity

- **Raw Water** is untreated surface or groundwater.
- **Wastewater** is the used water of a community (domestic households and commercial businesses for washing food, dishes, clothes, and bodies and for toilet flushing) or industry that contains dissolved and suspended matter.
- **Sewershed** is a sewer collection system that flows to a single end point for treatment; akin to watersheds in the natural environment but focused on wastewater and built environment.
- **Source Control** is careful management of harmful substances that may be introduced into the wastewater collection system.
- **Reused Water** is water used more than once and has been treated to a level that allows for its reuse for a beneficial purpose.
- **Purified Water** is highly treated water of wastewater origin that has passed through proven multistage, multibarrier processes to produce water at the quality fit to supplement or provide supply for potable (drinking) water purposes, as verified through monitoring for its safety and as regulated by the State Water Resources Control Board Division of Drinking Water.
- **Acre-feet per Year (AFY)** is a metric for the volume of water use and/or supply over one year. One acre-foot equals about 326,000 gallons, or enough water to cover an acre of land (about the size of a football field) one foot deep.
- **Efficiency** is a metric for advanced water purification facilities (AWPF) calculated as purified water produced divided by the facility's design capacity; efficiency reflects an AWPF's online factor (i.e., percent of time equipment is online vs. offline for regular maintenance) as well as source water availability.
- **Million Gallons per Day (mgd)** is a measurement of flow that represents a volume of water supplied, treated, discharged, or conveyed over one day or a facility capacity (maximum physical limit). Used in context of average water/wastewater use over any timescale or peak flows over a shorter timescale.
- **Utilization** is the average amount of purified water used for potable reuse divided by potable reuse capacity; utilization is dependent on delivery point conditions (e.g., groundwater storage capacity and water demand).
- **Yield** is the annual volume of water produced by a facility or natural system; generally lower than the maximum production (design) capacity due to source water availability, maintenance, and other factors that affect AWPF efficiency.

Water Purification/Treatment

- **Riverbank Filtration is a form of treatment where surface water is pumped out of borewells drilled along stream banks. Riverbed sediments act as a filter to remove dissolved and suspended contaminants and pathogens via a combination of physical, chemical, and biological processes.**
- **Soil Aquifer Treatment (SAT)** is a natural, passive process that occurs when applying a non-potable water supply, such as recycled water, to a soil interface under controlled conditions to recharge a groundwater aquifer. As water percolates, soil filtration treats the supply through natural, physical, chemical, and biological processes.
- **Constructed Wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial communities to improve water quality.**
- **Granular Activated Carbon (GAC)** is used to remove chemicals that are dissolved in water.
- **Ozonation** is the process of applying ozone (03), a strong oxidant, to disinfect water.
- **Membrane Filtration is a process of physical separation to remove constituents from water or other liquid solutions or gasses.** Pressure is used to force water through a semi-permeable membrane that transmits water but stops other materials from passing through the membrane. Four common types of membrane filtration include the following:
  - **Microfiltration (MF)** membranes have an effective pore size of approximately 0.1 microns (μm), ranging from 0.03 to 5 μm, and are used to remove soil particles, cysts, algae, and some bacteria.
  - **Ultrafiltration (UF)** membranes have an effective pore size of approximately 0.01 μm, ranging from 0.002 to 0.1 μm, and remove humic materials, some viruses, and more bacteria than MF.
  - **Nanofiltration (NF)** membranes, which have an effective pore size of approximately 0.001 μm, can remove virtually all bacteria and viruses, as well as some salts and dissolved organics.
  - **Reverse Osmosis (RO)** membranes remove bacteria, viruses, nearly all contaminant ions, and most dissolved non-ions. RO is commonly used in desalination, a process that removes salt from saline water sources.
- **Advanced Oxidation** is one of the processes that can be used as a safety barrier in the water purification process. Hydrogen peroxide, ultraviolet (UV) light, and other processes are used in combination to form a powerful oxidant that provides further disinfection of water and breaks down chemicals.
- **Biofiltration** uses a bioreactor, or media containing living material, to capture and biologically degrade pollutants. Biofiltration may be used to treat wastewater, stormwater, or as part of multi-stage drinking water treatment.
- A **Multi-barrier Approach** is a paradigm for water treatment that prevents, reduces, or eliminates contamination risks by integrating robust treatment processes, operational procedures, and technical resources/tools, along with monitoring to confirm proper functionality and expected performance. A multi-barrier approach involves more than one treatment step and, depending on the circumstances, may include: riverbank filtration, SAT, constructed wetlands, GAC, biofiltration, ozonation, membrane filtration, RO, and/or advanced oxidation.

Wastewater Treatment Processes and Flow Streams

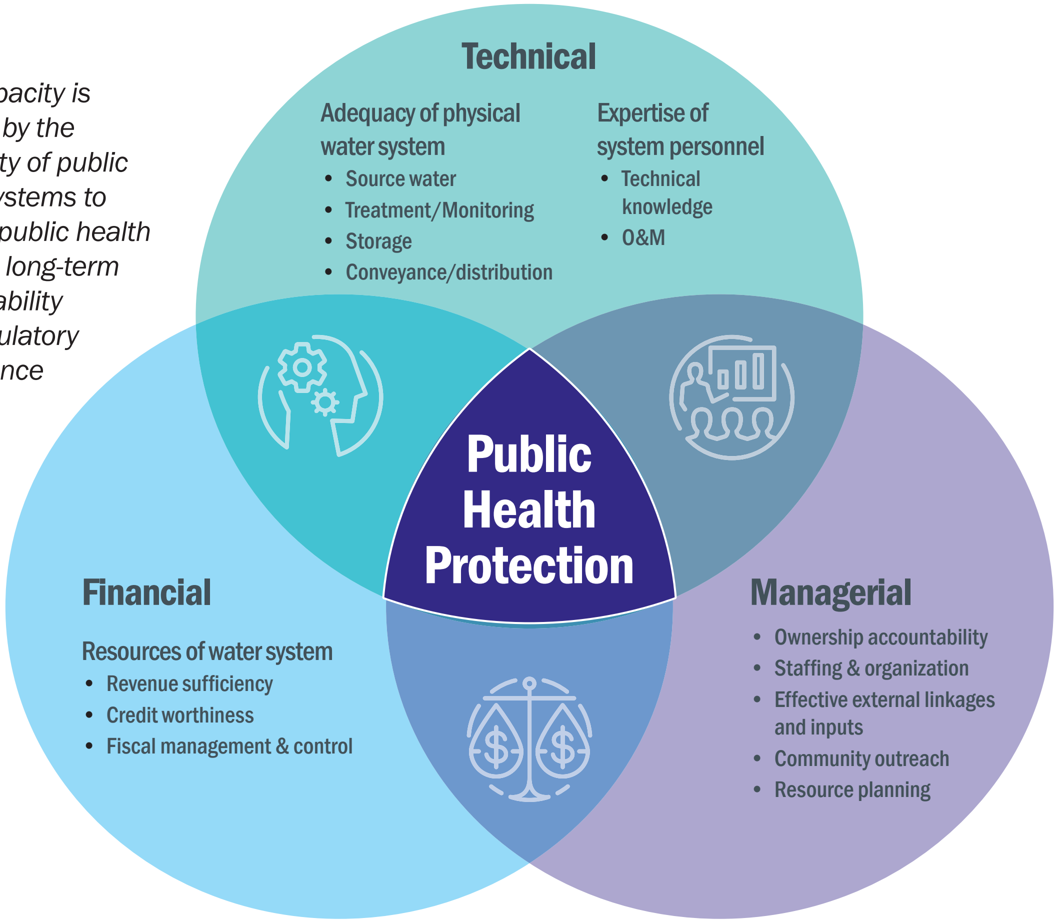
- **Influent** is the untreated water that flows into a wastewater treatment plant.
  - **Average Dry Weather Flow (ADWF)** is the average daily wastewater influent flow during the three lowest consecutive flow months of the year (e.g., June through August, or July through September), typically presented in million gallons per day (mgd).
- **Discharge** is the release of effluent that meets regulatory standards and is designated by a regulatory permit to be safe for discharge into the environment.
- **Effluent** is the treated water discharged from a wastewater treatment plant (WWTP).
  - **Remaining Effluent** is the amount of secondary- or tertiary-treated wastewater available for potable reuse (or other uses such as discharge or blending) after NPR demands, losses, and environmental flows are met; for planning purposes, the CoRe Plan assumes all remaining effluent would be available for potable reuse.
- **Primary Treatment** is a wastewater treatment process where solid matter is removed. The remaining liquid may be discharged (if allowed by regulations) or subjected to further treatment.
- **Secondary Treatment** is a wastewater treatment process where dissolved and suspended biological matter is removed to a non-potable level, so water may be disinfected and discharged into a receiving surface water or used for irrigation at controlled locations.
- **Tertiary Treatment** refers to treatment processes to remove nitrogen and phosphorus for uses such as irrigation, discharges into a highly sensitive or fragile ecosystem (e.g., estuaries, low-flow rivers), or blending with other environmental systems such as a river or groundwater basin. Tertiary treatment can include biological and filtration processes.
- **Advanced Water Treatment, or Advanced Water Purification**, refers to processes that purify water for uses such as irrigation or for water blended with other environmental systems such as a river, reservoir, or groundwater basin prior to reuse. Advanced water treatment can also include treatment processes to remove nitrogen and phosphorus to allow discharge into a highly sensitive or fragile ecosystem (e.g., estuaries, low-flow rivers, coral reefs, etc.).

Planning Approaches

- **Valley Water's One Water Plan** is a long-term endeavor that:
  - serves as a roadmap for integrated water resource planning,
  - reflects state, regional, and local policies in a countywide framework,
  - encompasses goals and objectives for flood protection, stream stewardship, and water supply, and
  - provides a framework for incremental, intentional, and measurable improvements.
- **Portfolio** is a combination of individual project components, a project alternative.
- **Programmatic Approach** is a strategic arrangement of individual, interlinked projects that collectively yield large-scale impacts, such as the Countywide approach to improving regional water supply reliability through considering a range of water reuse opportunities.
- **Rubric** is a framework used for evaluating the potable reuse portfolios based on various regulatory criteria.

Regulations and Permits

- **National Pollutant Discharge Elimination System (NPDES)** was instituted as part of the Clean Water Act, a permit program that controls water pollution by regulating point sources of discharge.
- **Title 22 Standards** are the requirements established by the State Water Resources Control Board Division of Drinking Water (formerly the California Department of Public Health) for the production and use of recycled water. Title 22, Chapter 3, Article 3 of the California Code of Regulations, outlines the level of treatment required for allowable uses for recycled water. The most typical uses include irrigation, firefighting, residential landscape watering, industrial uses, food crop production, construction activities, commercial laundries, toilet flushing, road cleaning, recreational purposes, lakes, ponds, and decorative fountains. Section 13550 of the California Water Code is a declaration by the State Legislature that the use of potable water is a waste if recycled water is available.
- **TMF Capacity**—technical, managerial, and financial capacity—is a concept first introduced by Congress in the 1996 Amendments to the Safe Drinking Water Act. The concept derives from a philosophy that capable water systems consistently provide safe and reliable water service, meet water quality standards required by regulations, and practice ongoing vigilance in operations and maintenance of facilities to protect the public's drinking water supply. To describe capability, Congress used the term "capacity development" with three components: technical, managerial, and financial. As shown in the following figure, a water system capable of protecting public health must have adequate capacity in all three components for near-term and long-term sustainability.


Technical
Adequacy of physical water system
• Source water
• Treatment/Monitoring
• Storage
• Conveyance/distribution
Expertise of system personnel
• Technical knowledge
• O&M
Public Health Protection
Financial
Resources of water system
• Revenue sufficiency
• Credit worthiness
• Fiscal management & control
Managerial
• Ownership accountability
• Staffing & organization
• Effective external linkages and inputs
• Community outreach
• Resource planning

TMF capacity is defined by the capability of public water systems to protect public health through long-term sustainability and regulatory compliance

Visual Glossary-2. The capability of public water systems to protect public health through long-term sustainability and regulatory compliance requires TMF capacity

Note: Figure adapted from a USEPA webpage, "Building the Capacity of Drinking Water Systems: Learn about Capacity Development"

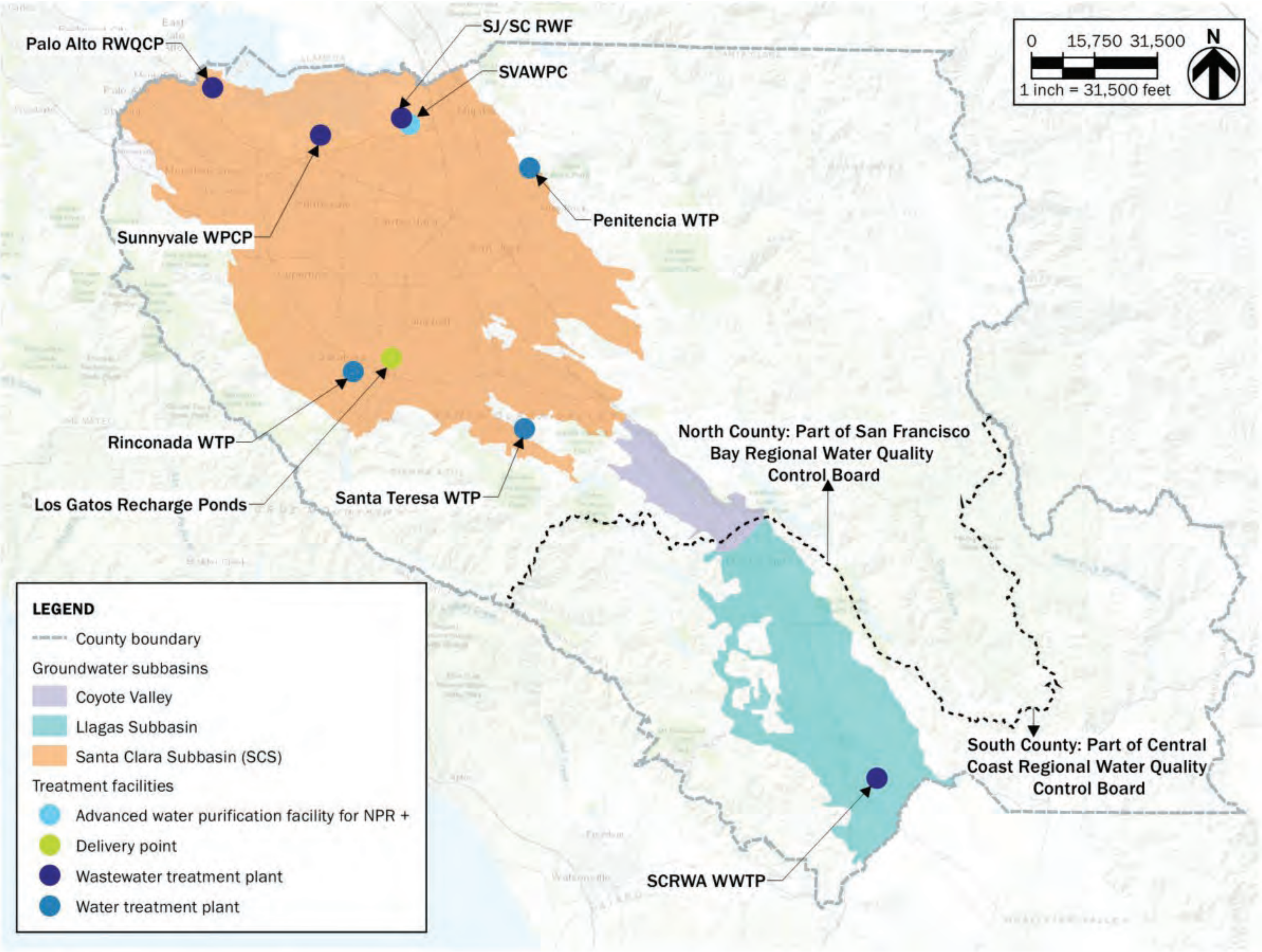
CoRe Plan Partnerships and Engagement

- **Partner Agencies** consist of staff from the cities of Palo Alto, Mountain View, Sunnyvale, San José, Santa Clara, Morgan Hill, and Gilroy that represent the four recycled water producers in Santa Clara County, along with owners/operators of recycled water systems. Valley Water will work closely with these partner agencies to secure source water for reuse and help the Partner Agencies meet their own reuse supply goals.
- **Project Partners** consist of the Partner Agencies and Valley Water. Collectively, they form the **Project Partner Group (PPG)** that meets periodically to develop and shape the CoRe Plan's projects and portfolios.
- **Executive Leadership Group (ELG)** refers to executive-level representatives (e.g., city manager or division manager) from the Partner Agencies who contribute strategic direction to the CoRe Plan.
- **Stakeholder Task Force (TF)** refers to a group convened for the purpose of providing input to Valley Water and the Project Partners with respect to developing the CoRe Plan. The Stakeholder TF is composed of representative interests/organizations related to business/economy, chambers of commerce, planning, public policy, water rates advocacy, environmental advocacy, environmental justice, medical community, diversity, stormwater, groundwater, other water and recycled water suppliers/agencies.
- **Independent Advisory Panel (IAP)** is a third-party body composed of leading potable reuse researchers and subject matter experts convened to review and provide feedback on proposed CoRe Plan projects, portfolios, and options related to technical feasibility and regulatory compliance. Panel members include:
  - James Crook, PhD, PE, BCEE
  - Katherine Cushing, PhD
  - Jean Moran, PhD
  - Adam Olivieri, DrPH, PE
  - Mehul Patel, PE
  - Shane Snyder, PhD

Santa Clara County Geography and Groundwater Basins/Subbasins

The CoRe Plan refers to North County and South County as general reference points. These terms are informal as used in this plan, yet generally consistent with the groundwater benefit zone boundaries. The following terms and figure below offer further context.

- **North County** refers to the area north of Metcalf Road, which encompasses San José, Santa Clara, Sunnyvale, Palo Alto, Mountain View, and other municipalities.
  - The North County sits atop the **Santa Clara Subbasin** (green shaded area in the figure), an area within the boundaries of the San Francisco Bay Regional Water Quality Control Board.
- **South County** refers to the area south of Metcalf Road, including Coyote Valley, Morgan Hill, and Gilroy.
  - The area south of Metcalf Road and north of Cochrane Road is the **Coyote Valley Recharge Area** (pink shaded area), which is part of the Santa Clara Subbasin.
  - The **Llagas Subbasin** is the southernmost groundwater subbasin (purple shaded area) and a critical water supply source for the cities of Morgan Hill and Gilroy.
  - This area is within the boundaries of the Central Coast Regional Water Quality Control Board.



Visual Glossary-3. Santa Clara County general location, groundwater subbasins, and existing water/wastewater treatment facilities

Abbreviations

AACE	Association for the Advancement of Cost Engineering
AB	Assembly Bill
ADWF	average dry weather flow
AFY	acre-feet per year
AWPF	advanced water purification facility
BARR	Bay Area Regional Reliability
Cal Water	California Water Service Company
CCR	California Code of Regulations
CEC	constituent of emerging concern
CEO	Chief Executive Officer
CEQA	California Environmental Quality Act
CIWQS	California Integrated Water Quality System
COO	Chief Operating Officer
CoRe	Countywide Water Reuse
County	Santa Clara County
DBFOM	design-build-finance-operate-maintain
DDW	State Water Resources Control Board's Division of Drinking Water
DOO	Deputy Operating Officer
DPR	direct potable reuse
EIR/S	Environmental Impact Report/Statement
EPASD	East Palo Alto Sanitary District
FAT	full advanced treatment
GM	General Manager
GWR	groundwater recharge
IAP	Independent Advisory Panel
IPR	indirect potable reuse
ISRF	Infrastructure State Revolving Fund Loan Program
JPA	joint powers authority
LAFCO	Local Agency Formation Commission
LGRP	Los Gatos recharge ponds system
LRV	log reduction value
MBR	membrane bioreactor
mg/L	milligrams per liter
mgd	million gallons per day
MH	Morgan Hill
µm	micron(s), micrometer(s)
NPDES	National Pollutant Discharge Elimination System
NEPA	National Environmental Protection Act

North County	northern portion of Santa Clara County (see Glossary)
NPR	non-potable reuse
NPR+	enhanced NPR, a blend of NPR with purified water from AWPF
O&M	operations and maintenance
P3	public-private partnership
PR	potable reuse
Regional Board	Regional Water Quality Control Board
RO	reverse osmosis
ROC	RO concentrate
RWA	raw water augmentation
RWC	Valley Water Board's Recycled Water Committee
RWMP	Recycled Water Master Plan
RWQCP	Palo Alto Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SNMP	Salt and Nutrient Management Plan
South County	southern portion of Santa Clara County (see Glossary)
SRF	Clean Water State Revolving Fund Loan Program
State Board	State Water Resources Control Board
SVAWPC	Silicon Valley Advanced Water Purification Center
SWA	surface water augmentation
TDS	total dissolved solids
TM	technical memorandum
TMF	technical, managerial, and financial
TWA	treated water augmentation
UV	ultraviolet
UWMP	Urban Water Management Plan
Valley Water	Santa Clara Valley Water District
WDR	waste discharge requirements
WIFIA	Water Infrastructure Finance and Innovation Act
WPCP	Sunnyvale Water Pollution Control Plant
WQOs	water quality objectives
WRR	water reclamation requirements
WSMP 2040	Valley Water's Water Supply Master Plan 2040
WTP	water treatment plant
WWTP	wastewater treatment plant

Countywide Water Reuse Master Plan (CoRe Plan) Appendices

Prepared for
Santa Clara Valley Water District (Valley Water)
June 2021

Brown AND Caldwell
75 E Santa Clara Street, Suite 375
San José, CA 95113

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Table of Contents

Appendix A: Feasible Project Portfolios

Appendix A-1: Feasible Project Portfolios Technical Memorandum 5
Appendix A-2: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield 125
Appendix A-3: Design Criteria 157
Appendix A-4: Preliminary Project Designs 183
Appendix A-5: Basis of Cost 209
Appendix A-6: Cost Estimates 245
Appendix A-7: Evaluation and Risk Assessment Tool 427
Appendix A-8: Treated Water Augmentation Pre-Screening Analysis 455
Appendix A-9: Evaluation of Onsite Reuse in Santa Clara County 481
Appendix A-10: Flexible Implementation of Potable Reuse - via San José AWPF 497
Appendix A-11: Flexible Implementation of Potable Reuse - via Palo Alto AWPF 597

Appendix B: Regulatory Compliance

Appendix B-1: Regulatory Compliance Strategy Technical Memorandum 705
Appendix B-2: Regulatory Framework Technical Memorandum 789

Appendix C: Hydraulic Modeling

Appendix C-1: Modeling Plan and Results 847
Appendix C-2: SBWR System Master Plan Updates 871

Appendix D: Project Definition, Roles, and Responsibilities 917

Appendix E: Baseline Analysis

Appendix E-1: Baseline Analysis 957
Appendix E-2: Recycle Hill Geotechnical Preliminary Study 1023

Appendix F: Conceptual Alternatives 1075

Appendix G: ROC Management Reference Files 1147

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Appendix A-1: Feasible Project Portfolios Technical Memorandum

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Technical Memorandum

75 E Santa Clara Street, Suite 375
San José, CA 95113
T: 408.703.2535

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
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Appendix A-1

Subject:	Feasible Project Portfolios
Date:	June 30, 2020 (reissued April 19, 2021)
To:	Miguel Silva, PMP, Valley Water, Project Manager
From:	Jenny Gain, P.E., Brown and Caldwell, Consultant Team Project Manager
Copy to:	David Tucker, Valley Water, Assistant Project Manager

Prepared by:	Marc Nakamoto, P.E., Brown and Caldwell California License C63282
	Melanie Holmer, P.E., Brown and Caldwell California License C63236
	Curtis Lam, P.E., HydroScience Engineers California License C59049
	Brian Pecson, Ph.D., P.E., Trussell Technologies California License C80440
Reviewed by:	Brett Farver, P.E., Brown and Caldwell California License C58466

Limitations:
This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Table of Contents

List of Figures iv
List of Tables....vi
List of Abbreviations viii
Executive Summary 1
Project Elements....2
  Treatment Facilities 2
  Residuals Management....4
  Conveyance/Distribution/Delivery Points 4
Portfolio Development....4
  NPR/NPR+ Expansion (Featured in All Portfolios)....5
  Portfolio 1 - San José AWPF 5
  Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF....6
  Portfolio 4 - Separate Palo Alto and Sunnyvale AWPFs for GWR....7
  South County Reuse Options 8
Economic Assessment....9
Portfolio Evaluation and Risk Assessment Tool 11
Section 1: Introduction....12
1.1 Types of Reuse 14
1.2 Regulatory Setting....14
  1.2.1 Environmental Requirements....14
  1.2.2 Potable Reuse....15
1.3 Environmental Setting....18
Section 2: Project Elements....19
2.1 Treatment Facilities....19
  2.1.1 Source Water 21
  2.1.2 Delivery Point 26
  2.1.3 Treatment Processes 32
2.2 Residuals Management....43
  2.2.1 ROC Management for San José AWPF (24 mgd)....47
  2.2.2 ROC Management for Combined Regional AWPF in Palo Alto (24.5 mgd)....47
  2.2.3 ROC Management for Combined Regional AWPF in Sunnyvale (24.5 mgd) 48
  2.2.4 ROC Management for Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd) 48
  2.2.5 ROC Management for Morgan Hill AWPF (2 mgd)....49
2.3 Conveyance/Distribution 49
  2.3.1 NPR/NPR+ Distribution Systems 50
  2.3.2 Interties between Recycled Water Systems 57
  2.3.3 PR Conveyance Infrastructure 60

Section 3: Portfolio Development....62
3.1 NPR/NPR+ Expansion (Featured in All Portfolios)....62
3.2 Portfolio 1 - San José AWPF....63
3.2.1 Portfolio 1a – San José AWPF for GWR (LGRP)....63
3.2.2 Portfolio 1b – San José AWPF for RWA (Penitencia WTP)....65
3.2.3 Portfolio 1c and 1d – San José AWPF for TWA....68
3.3 Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF....72
3.3.1 Portfolio 2a – Combined Regional AWPF in Palo Alto for GWR (LGRP)....73
3.3.2 Portfolio 2b – Sunnyvale AWPF Site for GWR (LGRP)....78
3.4 Portfolio 4 – Separate Palo Alto and Sunnyvale AWPFs for GWR....82
3.5 South County Reuse Options....85
3.6 Future Opportunities and Alternative Elements....91
3.6.1 Potential Future NPR Projects....91
3.6.2 System Interties....91
3.6.3 Alternative PR Alignments....91
3.6.4 Potential Future PR Projects....92
3.7 ROC Management Cost Summary....96
Section 4: Economic Assessment....96
4.1 Life-Cycle Evaluation....96
Section 5: Portfolio Evaluation and Risk Assessment Tool....101
5.1 Evaluation Criteria and Assessment Methodology....101
5.2 Risk Assessment Summary....105
5.3 South County Elements Evaluation....105
5.4 Evaluation Sensitivity Analysis and Summary....106
References....107

List of Figures

Figure ES-1. Partner Agencies' sewershed areas and cities contributing flows....1
Figure 1-1. Summary of PR forms and associated pathogen reduction requirements....16
Figure 2-1. Dry-weather influent projections from the SBWR Strategic and Master Planning Report, with adjusted flow range....22
Figure 2-2. Dry-weather influent projections from the Palo Alto Long-Range Facilities Plan, with adjusted flow range....23
Figure 2-3. Dry-weather influent projections from the Sunnyvale WPCP Basis of Design Report (BODR), with adjusted flow range....24
Figure 2-4. LGRP infrastructure improvements....27
Figure 2-5. Morgan Hill recharge locations....29
Figure 2-6. RWA delivery point facilities (Penitencia WTP) and improvements....31

Figure 2-7. Average Monthly Production at Penitencia and Rinconada WTPs........32
Figure 2-8. Palo Alto NPR+ process flow diagram........35
Figure 2-9. NPR+ process flow diagram for San José AWPF (based on SVAWPC)........36
Figure 2-10. AWPF process flow diagram for GWR........38
Figure 2-11. Morgan Hill satellite treatment facility process flow diagram........38
Figure 2-12. AWPF process flow diagram for RWA........41
Figure 2-13. AWPF process flow diagram for TWA........43
Figure 2-14. ROC management strategies, North County (as identified by the ROCMP Team)........45
Figure 2-15. Expansion of existing NPR/NPR+ distribution systems Countywide........55
Figure 2-16. Potential recycled water system interties........59
Figure 3-1. Portfolio 1a PR from San José AWPF for GWR (LGRP)........64
Figure 3-2. Portfolio 1b PR overview........66
Figure 3-3. Portfolio 1c PR from San José AWPF for TWA........69
Figure 3-4. Portfolio 1d PR from San José AWPF for TWA........70
Figure 3-5. Portfolio 2a PR overview........75
Figure 3-6. Portfolio 2b PR overview........79
Figure 3-7. Portfolio 4 PR overview........83
Figure 3-8. Morgan Hill potential NPR distribution system........86
Figure 3-9. Transmission line from SBWR to Morgan Hill for NPR+ distribution........87
Figure 3-10. Transmission line from proposed Morgan Hill AWPF to San Pedro Recharge Ponds........88
Figure 3-11. Transmission line from proposed Morgan Hill AWPF to Anderson Reservoir........89
Figure 3-12. West County TWA overview........95
Figure 5-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward engineering feasibility........103
Figure 5-2. Example Risk Matrix comparison of portfolios and options with likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis........105

List of Tables

Table ES-1. Summary of Projected Annual Flows and Yields 3
Table ES-2. Summary of Projected Long-Term NPR Demands by Partner Agency....5
Table ES-3. Portfolios 1a-1d Comparison of Key Attributes 6
Table ES-4. Portfolios 2a and 2b Comparison of Key Attributes 7
Table ES-5. Portfolio 4 Summary of Key Attributes 8
Table ES-6. Overview of South County Reuse Options....9
Table ES-7. North County Portfolios Economic Comparison Summary 10
Table ES-8. South County Reuse Options Economic Comparison Summary 11
Table 1-1. Approaches to maintain public health protection in DPR settings....18
Table 2-1. Project Elements: Treatment Facilities 20
Table 2-2. Range of Projected 2035 WWTP Influent Flows [a]....21
Table ES-1. Summary of Projected Annual Flows and Yields 25
Table 2-4. Various Treatment Processes used by AWPFs 33
Table 2-5. Estimated Costs for NPR+ AWPF....36
Table 2-6. GWR FAT-Based Advanced Treatment Performance....37
Table 2-7. Log Removal Credits for Morgan Hill Satellite Facility and AWPF 39
Table 2-8. RWA FAT-Based Advanced Treatment Performance 40
Table 2-9. TWA FAT-Based Advanced Treatment Performance 42
Table 2-10. ROC Management Recommendations from ROCMP team 44
Table 2-11. ROC management strategies for Portfolio 1, San José AWPF (24 mgd) 47
Table 2-12. ROC Management Strategies for Portfolio 2a, Combined Regional AWPF in Palo Alto (24.5 mgd)....48
Table 2-13. ROC management strategies for Portfolio 2b, Combined Regional AWPF in Sunnyvale (24.5 mgd) 48
Table 2-14. ROC Management Strategies for Portfolio 4, Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd)....49
Table 2-15. ROC Management Strategies for Morgan Hill AWPF (2 mgd) Evaporation Pond in Gilroy 49
Table 2-16. Potential Future NPR/NPR+ Projects and Cost Estimates for Recycled Water System Expansions....52
Table 2-17. Summary of Potential Recycled Water System Interties 58
Table 3-1. Portfolio 1a Facilities Summary....63
Table 3-2. Portfolio 1a Estimated Cost Summary from San José AWPF for GWR (LGRP)[a]....65
Table 3-3. Portfolio 1b Facilities Summary....67
Table 3-4. Portfolio 1b Estimated Cost Summary[a]....67

Table 3-5. Portfolio 1c Facilities Summary....71
Table 3-6. Portfolio 1d Facilities Summary....71
Table 3-7. Portfolio 1c Estimated Cost Summary....72
Table 3-8. Portfolio 1d Estimated Cost Summary....72
Table 3-9. Portfolio 2a Facilities Summary....77
Table 3-10. Portfolio 2a Estimated Cost Summary[a]....78
Table 3-11. Portfolio 2b Facilities Summary....81
Table 3-12. Portfolio 2b Estimated Cost Summary....82
Table 3-13. Portfolio 4 Facilities Summary....84
Table 3-14. Portfolio 4 Estimated Cost Summary....85
Table 3-15. Morgan Hill Alternatives Comparison Summary....90
Table 3-16. Summary of Purified Water Pipeline Alignments by Portfolio....92
Table 3-17. West County TWA Scenario Facilities Summary....93
Table 3-18. West County TWA Scenario Estimated Cost Summary....94
Table 4-1. Costs Included in Life-Cycle Comparisons....97
Table 4-2. References for Economic Comparison of Life Cycles....98
Table 4-3. South County Reuse Options Economic Comparison Summary – 30-year Life Cycle....99
Table 4-4. Portfolios Economic Comparison Summary – 30-year Life Cycle....99
Table 4-5. South County Reuse Options Economic Comparison Summary – 100-year Life Cycle....100
Table 4-6. Portfolios Economic Comparison Summary – 100-year Life Cycle....100
Table 5-1. Evaluation Criteria and Weighting Factors....101
Table 5-2. South County NPR Options Qualitative Comparison....106
Table 5-3. South County PR Options Qualitative Comparison....106

List of Abbreviations

$/AF	dollar per acre-foot
µm	micrometer
AB	Assembly Bill
ABAG	Association of Bay Area Governments
ADWF	average dry weather flow
AF	acre-foot/feet
AFY	acre-foot/feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
BAC	biologically active carbon
BODR	Basis of Design Report
Cal Water	California Water Service Company
CC	Central Coast
CCCI	California Construction Cost Index
CCSCE	Center for the Continuing Study of the California Economy
CEC	constituent of emerging concern
CEQA	California Environmental Quality Act
CIWQS	California Integrated Water Quality System
County	Santa Clara County
CoRe Plan	Countywide Water Reuse Master Plan
DBP	disinfection byproduct(s)
DDW	Division of Drinking Water
DPR	direct potable reuse
EIR	Environmental Impact Report
EPASD	East Palo Alto Sanitary District
FAT	full advanced treatment
FM	force main
FSRWE	Feasibility Study for Recycled Water Expansion
ft	foot/feet
GAC	granular activated carbon
GHG	greenhouse gas
gpm	gallon(s) per minute
GWR	groundwater recharge
HDPE	high-density polyethylene
hp	horsepower
hr	hour(s)
IAP	Independent Advisory Panel
in.	inch(es)
IPR	indirect potable reuse
kWh	kilowatt-hour(s)
L	liter(s)
LATP	Los Altos Treatment Plant
lb	pound(s)
LF	linear foot/feet
LGRP	Los Gatos recharge ponds system
LRV	log reduction value
M	million(s)
Master Plan	Countywide Water Reuse Master Plan
MBR	membrane bioreactor
MF	microfiltration
MG	million gallons
mg/L	milligram(s) per liter
mgd	million gallons per day
mJ/cm^2	millijoules per square centimeter
MP	midpoint
N/A	not applicable
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NEPA	National Environmental Protection Act
nm	nanometer
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NPR+	enhanced non-potable reuse
NPV	net present value
NWRI	National Water Research Institute
O&M	operations and maintenance
O_3	ozone
off-spec	off-specification
PA/MV	Palo Alto/Mountain View
PDT	pressure decay test
PFAS	per- and polyfluoroalkyl substances
PL	pipeline
PPG	Project Partner Group

PR	potable reuse
PS	pump station
R&R	replacement and renewal
Regional Board	Regional Water Quality Control Board
RMA	Resource Management Associations
RO	reverse osmosis
ROC	RO concentrate
ROCMP	ROC Management Plan
RWA	raw water augmentation
RWF	regional wastewater facility
RWMP	Recycled Water Master Plan
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBA	South Bay Aqueduct
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SJ/SC	San José-Santa Clara
SJ Muni	San José Municipal Water System
SJW	San Jose Water[1]
SNMP	Salt and Nutrient Management Plan
State Board	State Water Resources Control Board
SVAWPC	Silicon Valley Advanced Water Purification Center
SWA	surface water augmentation
TAF	thousand acre-feet
TBD	To be determined
TDH	total dynamic head
TDS	total dissolved solids
TM	technical memorandum
TOC	total organic carbon
TWA	treated water augmentation
UF	ultrafiltration
UV	ultraviolet
UV/AOP	ultraviolet/advanced oxidation process
UVT	UV transmittance
UWMP	Urban Water Management Plan
V/G/C	virus/*Giardia/Cryptosporidium*
V/Q	volume divided by flow
Valley Water	Santa Clara Valley Water District
WEAP	Water Evaluation and Planning System
WPCP	Water Pollution Control Plant
WQO	water quality objective
WSMP	Water Supply Master Plan
WTP	water treatment plant
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in their name, though City of San José does.

Executive Summary

Santa Clara Valley Water District (Valley Water) initiated development of the Countywide Water Reuse Master Plan (Master Plan; also referred to as the *CoRe Plan*) to integrate existing recycled water studies, plans, and infrastructure in partnership with four existing recycled water systems (RWS) delivering non-potable reuse (NPR) water in Santa Clara County (County) (Figure ES-1). Referred to as Partner Agencies, the NPR producers include:

- **San José/Santa Clara Regional Wastewater Facility (SJ/SC RWF):** The SJ/SC RWF produces recycled water for wholesale distribution via the South Bay Water Recycling (SBWR) system.
- **City of Palo Alto:** The Palo Alto Regional Water Quality Control Plant (RWQCP) produces recycled water for distribution in the Palo Alto / Mountain View (PA/MV) RWS.
- **City of Sunnyvale:** The Sunnyvale Water Pollution Control Plant (WPCP) produces recycled water for distribution in the Sunnyvale RWS.
- **South County Regional Wastewater Authority (SCRWA):** SCRWA produces recycled water for distribution in the South County RWS.

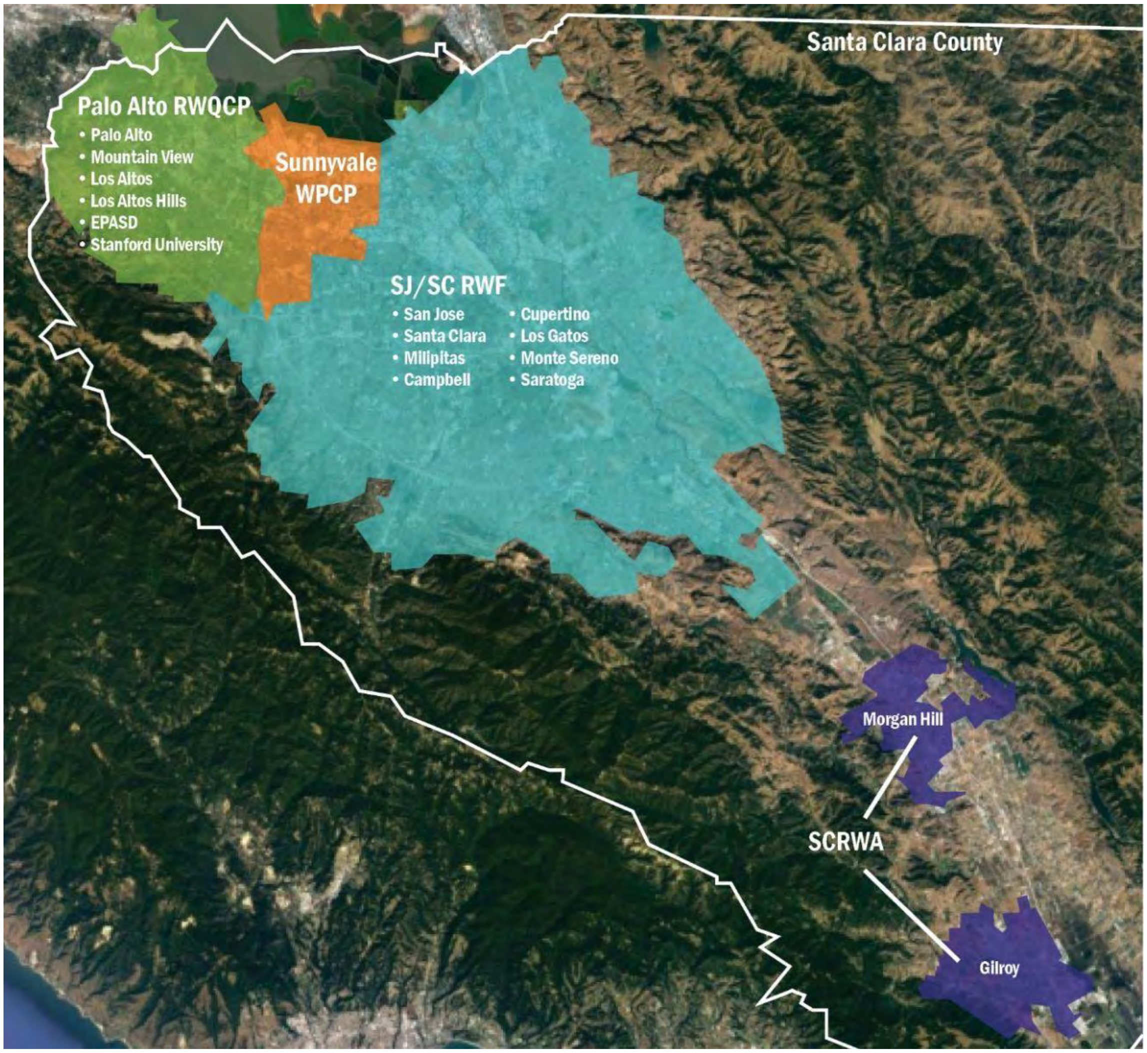

Figure ES-1. Partner Agencies' sewershed areas and cities contributing flows

EPASD = East Palo Alto Sanitary District

The Master Plan provides a framework to make collaborative decisions related to integrated actions to increase the region's water supply reliability through reuse, as applied to a planning horizon through 2040. Objectives of the Master Plan include:

1. **Determine reuse supply availability and benefits.**
2. **Evaluate potential regional integration.**
3. **Guide system expansion through interagency agreements and governance.**
4. **Solicit input and generate regional support for the Master Plan via coordination and stakeholder outreach.**

The Master Plan presents and evaluates several portfolios (formerly called alternatives) of potential future reuse projects, along with related information that may support potential future interagency agreements and governance.

This technical memorandum (TM), the Feasible Project Portfolios TM (Appendix A-1 to the CoRe Plan), is an interim deliverable that accomplishes the following:

- Further develops three water reuse portfolios identified in the Conceptual Alternatives TM (Appendix F) to be carried forward for feasibility analysis
- Further defines project elements—essentially the building blocks of the three portfolios—to a preliminary (10%) design level
- Evaluates the portfolios against several criteria, such as economics, environmental benefits/impacts, and ease of implementation
- Serves as a critical foundation for the Master Plan by framing each portfolio's benefits, costs, and risks

Project Elements

The portfolios are composed of sets of project elements in two general categories: treatment facilities and conveyance/distribution facilities (i.e., pipelines and pump stations).

Treatment Facilities

The treatment facilities are distinguished by source water, treatment level, and delivery point, as summarized below.

Source Water. The proposed advanced water purification facilities (AWPF) treat wastewater from four sources:

- SJ/SC RWF
- Palo Alto RWQCP
- Sunnyvale WPCP
- Morgan Hill trunk sewer (for satellite treatment)

Source water availability depends on several factors, including projected wastewater treatment plan (WWTP) influent and outflow streams (e.g., NPR demands, environmental flows, and losses). To account for uncertainty in future influent projections, a range of flows was considered. The lower bound assumes influent remains constant through the planning horizon. The upper bound uses the same baseline but assumes flows increase at the rate projected in individual agencies' wastewater or recycled water master plans.

As shown in Table ES-1, San José/Santa Clara RWF is expected to have sufficient source water to meet Valley Water's goal of 24,000 acre-feet per year (AFY) for potable reuse (PR). For an AWPF dependent on effluent from Sunnyvale or Palo Alto, there is a risk of lower yield (below Valley Water's goal). In South County, the satellite option depends on the availability of raw wastewater from Morgan Hill, which fluctuates seasonally. More details on the flow evaluation are included in Appendix A-2 (Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield).

Table ES-1. Summary of Projected Annual Flows and Yields

Location	Annualized Flows Projected for 2035 (mgd)								Anticipated Potable Reuse Yield (AFY)
	WWTP Influent		Avg. Annual Environmental Flows & Misc. Losses	Future NPR Demand	ROC from NPR+	Calculated Net Effluent Remaining [a]	Purified Water		
	Avg. Dry Weather Flow (ADWF)	Avg. Annual Flow					Assumed Production Capacity	Avg. Production	
SJ/SC	98.4 - 106	100.5 - 108.2	--	27.6 [d]	1.8 [e]	71 - 78.7	24	21.6 [f]	24,000 [f]
Palo Alto	17.7 - 19.6	19.3 - 21.3	3.3 [b]	2.5	0.2	13.3 - 15.3	14	10.5 - 11.8 [g]	11,700 - 13,200 [g]
Sunnyvale	11.2 - 15.9	11.9 - 16.9	4.0 [c]	1.5	0.1	6.3 - 11.3	10.5	4.9 - 8.8 [g]	5,500 - 9,800 [g]
Morgan Hill	--	--	--	--	--	2.1	2.1	1.7	1,900

a. Calculated Net Effluent Remaining = Avg. Annual WWTP Influent – [Environmental Flows & Misc. Losses + Future NPR Demand + ROC from NPR$^+$]

b. 3 mgd of future flows to Renzel Marsh and potentially to horizontal levees and 0.3 mgd for losses in/around RWQCP (from 2015 Urban Water Management Plan)

c. 4 mgd for evaporation and capping at Sunnyvale's treatment ponds

d. SBWR retailers' future NPR demand, as provided by SBWR staff. Does not include potential future NPR demand in Morgan Hill.

e. ROC stream related to existing Silicon Valley Advanced Water Purification Center (SVAWPC) operating at 8 mgd capacity; used to improve water quality of NPR to meet a total dissolved solids (TDS) target of 500 milligrams per liter (mg/L) year-round.

f. San José AWPF was sized assuming a 90% online factor, due to extent calculated net effluent remaining exceeds the 24,000 AFY goal.

g. Palo Alto and Sunnyvale AWPFs were sized to maximize production of purified water while also maintaining a reasonable AWPF efficiency, based on source flow availability. More details on flow availability and AWPF sizing are included in Appendix A-2.

mgd = million gallons per day

Treatment Level. The extent of treatment varies by AWPF and portfolio, based on the intended use of product water. The following types of reuse were considered in this analysis:

- **Non-potable reuse.** NPR systems in the County provide Title 22 disinfected tertiary recycled water for non-potable beneficial uses, such as landscape irrigation and industrial cooling.
- **Enhanced NPR, also referred to as NPR+.** To improve the quality of Title 22 recycled water for such uses, it can be blended with purified water (reverse osmosis [RO] treated or equivalent water quality).
- **Indirect potable reuse (IPR).** Characterized by use of an environmental buffer prior to becoming a potable water supply, IPR can be accomplished through groundwater recharge (**GWR**) or surface water augmentation (**SWA**).
- **Direct potable reuse (DPR).** Defined by the absence of a significant environmental buffer prior to becoming a potable water supply, DPR is accomplished through raw water augmentation (**RWA**) or treated water augmentation (**TWA**). State DPR regulations are in process of development and anticipated by December 2023.

Delivery Point. Delivery points refer to locations where treated water would be conveyed for reuse (NPR or PR). The delivery points considered in this TM, grouped by treated water type, include:

- NPR/NPR+: New and existing NPR users throughout the County

- GWR: Los Gatos Recharge Ponds (LGRP[2]) in North County and a combination of several percolation ponds in South County
- SWA: Valley Water's Anderson Reservoir[3] in South County, near Morgan Hill
- RWA: South Bay Aqueduct (SBA) terminal tank at Penitencia Water Treatment Plant (WTP)
- TWA: North Side Storage Tanks to serve the City of Santa Clara and San José Municipal Water System (SJ Muni) water distribution systems, the Gibraltar Reservoir to convey treated water south along Valley Water's Milpitas Pipeline, the Piedmont Valve Yard to convey treated water north along Valley Water's Milpitas Pipeline or south along Valley Water's East Pipeline, and the West Pipeline to serve Valley Water customers in the western portion of the County.

Residuals Management

Though level of treatment varies, each potential AWPF is anticipated to consist of a process train that includes reverse osmosis (RO), which generates a concentrate stream. RO concentrate (ROC) management strategies vary depending on AWPF location and capacity. Valley Water is considering various management options as part of a ROC Management Plan (ROCMP) currently being developed in a parallel, separate project with the Master Plan. The ROCMP team is informing the feasible portfolios evaluation, specifically in terms of site-specific ROC management options, costs, and permitting complexity.

Conveyance/Distribution/Delivery Points

Conveyance and distribution project elements include:

- NPR/NPR+ distribution system expansions (based on retailers' previous studies)
- Interties between recycled water systems, including between Sunnyvale and SBWR and/or Sunnyvale and PA/MV
- Effluent pipelines from WWTP to AWPFs for treatment
- Purified water pipelines from AWPFs to delivery points
- LGRP piping improvements
- Penitencia WTP improvements
- ROC pipelines
- Pump stations

Portfolio Development

The development of portfolios began in 2018 with identifying five conceptual portfolios and engaging Partner Agencies to select three conceptual portfolios and a variety of project elements for further development and evaluation.

The three portfolios selected for this evaluation each include a major PR project element(s) with source flow from the North County WWTPs, including the SJ/SC RWF, Palo Alto RWQCP, and Sunnyvale WPCP. Using source water from these facilities is the only way to potentially meet the 24,000 AFY PR goal. Treatment elements of the three portfolios are named using the potential facilities' locations and include:

- Portfolio 1: San José AWPF for GWR at LGRP, RWA at Penitencia WTP, or TWA in Santa Clara and San José distribution systems north of Highway 101 and turnouts along Valley Water's East Pipeline

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[2] Valley Water's system of recharge ponds located in Los Gatos are referred to as Los Gatos Recharge Ponds (LGRP) system in past documents. In recent documents and going forward, Valley Water is referring to the same facility as Los Gatos recharge system (LGRS).

[3] If Anderson Reservoir is decommissioned in the future, other reservoirs may need to be considered (e.g., Calero Reservoir).

- Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF for GWR at LGRP
- Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP

NPR/NPR+ elements and South County project elements were evaluated separately and may be incorporated into any portfolio.

NPR/NPR+ Expansion (Featured in All Portfolios)

NPR expansion is expected to occur throughout the County. NPR can minimize the need to increase potable water system capacity and treatment. Relative to producing water for PR, NPR is often a lower-cost water supply.

The project team compiled information from recycled water retailers' Urban Water Management Plans (UWMP) about NPR expansion to sum the total 2040 NPR demand (Table ES-2).

Table ES-2. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	2040 NPR Demand		Current Contractual Obligation[b]
		mgd	AFY[a]	
PA/MV RWS	Palo Alto Mountain View	2.5	2,800	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	Sunnyvale Cal Water (Cupertino) San Jose Water (Cupertino)	1.5	1,700	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	Santa Clara SJ Muni San Jose Water Milpitas	27.6	30,900[c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless agreement is extended)
SCRWA	Gilroy Morgan Hill	3.3 2.6	3,700 2,900[d]	None
Countywide	Total, excluding Morgan Hill Total, including Morgan Hill	34.9 37.5	39,100 42,000[d]	

a. *Projected 2040 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Long-term demands assume that any existing NPR is estimated into the future year UWMP demands, if applicable.*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

c. *Reflects updated NPR demands provided by SBWR staff in January 2019.*

d. *Reflects Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

Portfolio 1 - San José AWPF

Portfolio 1 considers using available effluent from the SJ/SC RWF to feed a new AWPF adjacent to the existing Silicon Valley Advanced Water Purification Center (SVAWPC). Four treatment and delivery options were evaluated:

- Portfolio 1a – San José AWPF for GWR, which delivers up to 24,000 AFY to LGRP for groundwater replenishment.
- Portfolio 1b – San José AWPF for RWA, which delivers up to 24,000 AFY to the SBA terminal tank located immediately upstream of the Penitencia WTP.
- Portfolio 1c – San José AWPF for TWA, which delivers up to 24,000 AFY to local drinking water distribution systems in two directions: east to the North Side Storage Tanks serving the cities of San

Jose and Santa Clara (portions north of Highway 101) and south to the existing Milpitas Pipeline at the Gibraltar Reservoir. Purified water sent through the Milpitas Pipeline could be blended with other treated water at the Piedmont Valve Yard and modulating valve vault near Penitencia WTP and conveyed to Valley Water turnouts along the East Pipeline.

- Portfolio 1d - San José AWPF for TWA, which delivers up to 24,000 AFY to local drinking water distribution systems in two directions: east to the North Side Storage Tanks serving the cities of San Jose and Santa Clara (portions north of Highway 101) and south (via a new pipeline parallel to the existing Milpitas Pipeline) to the Piedmont Valve Yard near Penitencia WTP for delivery to Valley Water turnouts along the East Pipeline.

The differences among Portfolios 1a through 1d are summarized in Table ES-3.

Table ES-3. Portfolios 1a-1d Comparison of Key Attributes

Criteria	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d
Supply source	SJ/SC RWF			
AWPF design capacity	24 mgd			
Reuse type	GWR	RWA	TWA	TWA
Delivery point(s)	LGRP	Penitencia WTP	North Side Storage Tanks and Gibraltar Reservoir to send water south via existing Milpitas Pipeline	North Side Storage Tanks and Piedmont Valve Yard to use East Pipeline
Anticipated yield (purified water)	24,000 AFY			
Purified water pump station, flow (in gallons per minute [gpm])	16,700 gpm[a]			
Purified water pump station, total dynamic head (TDH, in feet [ft])	400 ft	550 ft	250 ft to North Side Tanks 350 ft to Milpitas Pipeline	250 ft to North Side Tanks 350 ft to Piedmont Valve Yard
Conveyance pipeline length (in miles [mi]) and diameter (in inches)	18.1 mi (48”)	8.9 mi (48”)	3.9 mi (36”) 4.7 mi (24”)	8.2 mi (36”) 4.7 mi (24”)
Delivery point improvements	New pipeline: 4,700 ft (18-inch to 36-inch)	3-million-gallon (MG) storage tank[b], chemical dosing system, and 66-inch blend pipe	n/a	n/a
ROC management strategy	Blend ROC with SJ/SC RWF effluent at a new outfall (including a new pipeline and pump station) located beyond weir of existing outfall.			

a. 1 gpm = 0.00144 mgd

b. 3-MG storage tank is sized to provide about 3 hours' worth of operational purified water storage at Penitencia WTP. If the AWPF is offline, Valley Water could request a transfer from the State Water Project, which has an assumed 3- to 4-hour response time. (Valley Water, 2018)

Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF

Portfolio 2 considers combining available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for treatment at one AWPF that would provide regional benefit through GWR at LGRP. Sourcing one AWPF from two WWTPs (operated by two separate agencies) is uncommon and likely involves unique interagency and regulatory circumstances. In addition, source flow availability is a key consideration for a Palo Alto and Sunnyvale-based portfolio, as total combined WWTP influents may not be sufficient to meet Valley Water's 24,000-AFY PR goal. Two options were evaluated:

- Portfolio 2a – Combined Regional AWPF in Palo Alto for GWR (LGRP)
- Portfolio 2b – Combined Regional AWPF on Sunnyvale AWPF Site for GWR (LGRP)

Both options are designed to deliver up to 23,000 AFY to LGRP for GWR. Key attributes of Portfolios 2a and 2b are summarized in Table ES-4.

Table ES-4. Portfolios 2a and 2b Comparison of Key Attributes

Criteria	Portfolio 2a	Portfolio 2b
Supply source	Palo Alto	Sunnyvale
AWPF design capacity	24.5 mgd (24 mgd for PR; 0.5 mgd for NPR+ in Sunnyvale)	24.5 mgd (24 mgd for PR; 0.5 mgd for NPR+ in Sunnyvale)
Reuse type	GWR	GWR
Delivery point	LGRP	LGRP
Anticipated yield (purified water)	17,300 - 23,000 AFY[a]	17,300 - 23,000 AFY[a]
Effluent pipeline length and diameter	From Palo Alto RWQCP: 2.9-mi From Sunnyvale WPCP: 7.4-mi (36”)	From Palo Alto RWQCP: 10-mi (36”)
Purified water pump station, flow	16,700 gpm[b]	16,700 gpm[b]
Purified water pump station, TDH	400 ft	400 ft
Conveyance pipeline length and diameter	20.3 mi (48”)	17.1 mi (48”)
Delivery point improvements	New pipeline: 4,700 ft (18” to 36”)	New pipeline: 4,700 ft (18” to 36”)
ROC management strategy	Use a new pipeline and pump station to convey ROC to the RWQCP for blending with effluent at the existing outfall.	Discharge ROC at a new shallow water outfall at Guadalupe Slough for enhanced mixing.

a. Based on the range of projected influent using upper and lower bounds. See Section 2 and Appendix A-2 for details.

b. 1 gpm = 0.00144 mgd

Portfolio 4 - Separate Palo Alto and Sunnyvale AWPFs for GWR

Portfolio 4 considers using available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for GWR at the LGRP. In this portfolio, two AWPFs would be constructed to use available flow from each WWTP. The Sunnyvale AWPF would be located on Recycle Hill, and the Palo Alto facility would be on the former Los Altos Treatment Plant (LATP) site located in Palo Alto. Key elements of Portfolio 4 are summarized in Table ES-5.

Table ES-5. Portfolio 4 Summary of Key Attributes

Criteria		Palo Alto AWPF (1 of 2 AWPFs)	Sunnyvale AWPF (2 of 2 AWPFs)
AWPF design capacity		14 mgd	10.5 mgd
Reuse type		GWR	GWR
Delivery point		LGRP	LGRP
Anticipated yield (purified water)		11,700 – 13,200 AFY	5,500 – 9,800 AFY
Combined yield (purified water)		17,300[a] - 23,000 AFY	17,300[a] - 23,000 AFY
Purified water pump station, flow		9,720 gpm	6,950 gpm
Purified water pump station, TDH		130 ft	400 ft
Conveyance pipeline length and diameter	From AWPF to joint purified water pipeline	6.5 mi (36”)	2.2 mi (36”)
	From joint purified water pipeline to LGRP	13.7 mi (48”)	13.7 mi (48”)
Delivery point improvements		New pipeline: 4,700 ft (18” to 36”)	New pipeline: 4,700 ft (18” to 36”)
ROC management strategy		Use a new pipeline and pump station to convey ROC to the RWQCP for blending with effluent at the existing outfall.	Discharge ROC at a new shallow water outfall at Guadalupe Slough for enhanced mixing.

a. Difference due to rounding.
b. 1 gpm = 0.00144 mgd

South County Reuse Options

To explore solutions to augment Morgan Hill’s overall supply, the Project Team reviewed previous South County reuse work and developed new conceptual reuse options for consideration. South County reuse options may be incorporated into any of the portfolios.

The 2015 South County Recycled Water Master Plan (RWMP) (SCRWA, 2016) evaluated reuse alternatives for Morgan Hill, identifying NPR expansion near the SCRWA WWTP as the preferred option since conveying water north to Morgan Hill would require substantial energy. Recycled water service at the SCRWA facility is already challenged in meeting existing maximum day NPR demand in Gilroy (5.2 mgd in 2014), using most of the average dry weather influent flow (6.0 mgd in 2014).

The Master Plan is exploring several new project concepts, described below and summarized in Table ES-6.

- NPR+ delivered from the SBWR system, using a 5.8-mile extension originating near Metcalf Energy Center that could serve peak demands of up to 5 mgd to provide an estimated annualized NPR demand of up to 5,100 AFY in the Morgan Hill area.
- IPR via GWR, with water treated at a satellite WWTP and AWPF in Morgan Hill and then delivered to nearby percolation ponds within the Llagas Subbasin (for example, the San Pedro recharge ponds).
- IPR via SWA, with water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the south end of Anderson Reservoir. A corresponding flow from the Santa Clara Conduit could be supplied to the San Pedro and/or Main Avenue ponds to benefit the Llagas Subbasin, which underlies Morgan Hill and Gilroy.
- DPR via TWA, with water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the Morgan Hill drinking water distribution system.
- DPR via TWA, with water treated at a new AWPF adjacent to SCRWA in Gilroy and then delivered to the Morgan Hill drinking water distribution system.

Table ES-6. Overview of South County Reuse Options

Reuse Type	Source Flow	Delivery Point	Summary	Capital Cost ($2019 in millions)
NPR	SCRWA	New Morgan Hill NPR distribution system	Per the 2015 South County RWMP, extend pipeline parallel to existing joint sewer trunk line to convey recycled water from SCRWA in Gilroy to customers in Morgan Hill	$60[a]
NPR+	SBWR	New Morgan Hill NPR distribution system	Extend Silver Creek Pipeline from Metcalf Energy Center to customers in Morgan Hill; referred to as Morgan Hill Option 1 in this study and reflects full buildout of NPR to meet market demand.	$74[b]
GWR	Morgan Hill satellite WWTP and AWPF	San Pedro Ponds (assumed location for estimating costs)	Recharge Llagas Subbasin with purified water; referred to as Morgan Hill Option 2 in this study.	$125[b]
SWA	Morgan Hill satellite WWTP and AWPF	Anderson Reservoir	Pump purified water to Anderson Reservoir for blending and dilution, then recharge equal volume of raw water from the Santa Clara Conduit in Llagas Subbasin; referred to as Morgan Hill Option 3 in this study.	$145 [b]
SWA	SCRWA and Gilroy AWPF	Coyote Reservoir	Pump purified water from an AWPF at SCRWA (Gilroy) to Coyote Reservoir for blending and dilution. Coyote flows to Anderson Reservoir, allowing Morgan Hill to recharge equal volume from the Santa Clara conduit in Llagas Subbasin.	-- [c]
RWA	SCRWA and Gilroy AWPF	Pacheco Conduit	Pump purified water from an AWPF at SCRWA (Gilroy) to Pacheco Conduit for RWA at Santa Teresa and/or Rinconada WTPs, allowing Morgan Hill to recharge equal volume from the Santa Clara Conduit in Llagas Subbasin.	-- [c]
TWA	Morgan Hill satellite WWTP and AWPF	Morgan Hill engineered storage/potable distribution system	Deliver purified water from a satellite WWTP and AWPF in Morgan Hill to engineered storage, then to the Morgan Hill potable water distribution system.	-- [c]
TWA	SCRWA and Gilroy AWPF	Gilroy engineered storage/ potable distribution system	Deliver purified water from an AWPF at SCRWA to engineered storage, then to the Gilroy potable water distribution system.	-- [c]

a. *Cost from SCRWA (2016) escalated to 2019 dollars.*
b. *Cost calculated as part of Master Plan (see Appendix A-6, Cost Estimates)*
c. *Not available*

Preliminary design of all AWPFs in this TM involve full advanced treatment (FAT), which require ROC management solutions. Valley Water's ROCMP team reported that the best option for managing ROC from a Morgan Hill AWPF would require 80 to 100 acres of lined evaporation ponds, though a location or cost for the evaporation ponds has not been identified.

Economic Assessment

Capital and annual O&M costs were estimated for each portfolio and form the basis for the 30-year and 100-year life-cycle assessments. The lifecycle costs consist of capital; replacement and renewal (R&R) of major equipment; and O&M of new treatment facilities, pump stations, pipelines, and water supplies. Table ES-7 summarizes estimated costs for each North County portfolio, and Table ES-8 summarizes estimated costs for each South County reuse option. Cost estimates do not include land acquisition costs.

Table ES-7. North County Portfolios Economic Comparison Summary

	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
AWPF Capacity (mgd)	24	24	24	24	24.5	24.5	24.5
Costs $2019 [a]							
Total Capital Cost [b]	$635M	$630M	$535M	$585M	$765M	$765M	$805M
Annual O&M Cost [b]	$19.6M	$22.7M	$22.3M	$22.3M	$20.9M	$20.0M	$21.4M
30-Year Life-cycle Costs							
R&R Cost [b]	$190M	$235M	$230M	$230M	$195M	$195M	$225M
Total Life-cycle Cost, Present Value [b]	$975M	$1,045M	$955M	$1,000M	$1,110M	$1,095M	$1,170M
Life-cycle Unit Cost ($/AF) [b,c]	$2,400 – $3,000/AF	$2,500 – $3,100/AF	$2,300/AF	$2,400/AF	$2,800 – $3,800/AF	$2,800 – $3,700/AF	$3,000 – $4,000/AF
100-Year Life-cycle Costs							
R&R Cost [b]	$1,065M	$1,210M	$1,170M	$1,200M	$1,135M	$1,110M	$1,235M
Total Life-cycle Cost, Present Value [b]	$1,365M	$1,495M	$1,395M	$1,440M	$1,525M	$1,495M	$1,605M
Life-cycle Unit Cost ($/AF) [b,c]	$1,900 – $2,400/AF	$2,100 – $2,500/AF	$1,900/AF	$2,000/AF	$2,200 – $2,900/AF	$2,200 – $2,900/AF	$2,300 – $3,100/AF

a. *The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50% to +100%. In developing preliminary (10%) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30% to +50%). Values are rounded up to the nearest $5 million for capital costs, $100,000 for annual O&M costs; and $100 for life-cycle unit costs. All costs are presented in 2019 dollars.*

b. *ROC management is not included in summary costs. See portfolio descriptions in Sections 3 and 4 for information on ROC management costs as estimated in the Evaluation of ROC Management Options Final Report (Valley Water, 2020).*

c. *The range of unit costs represent the upper and lower bounds of assumed portfolio yield. See Appendix A-2 for additional detail on flow assumptions.*

Table ES-8. South County Reuse Options Economic Comparison Summary

	Option 1 (NPR+ from SBWR)	Option 2 (GWR)	Option 3 (SWA)
Supply yield (AFY)	2,900	1,900	1,900
Total Capital Cost [a, b]	$70M	$75M	$95M
Annual O&M Cost [a, b]	$2.6M	$6.8M	$7.1M
30-Year Life-cycle Costs			
R&R Cost [b,c]	$5M	$35M	$40M
Total Life-cycle Cost, Present Value [b,c]	$110M	$200M	$225M
Life-cycle Unit Cost ($/AF) [a, b,c,d]	$2,200/AF	$6,100/AF	$6,900/AF
100-Year Life-cycle Costs			
R&R Cost [b,c]	$20M	$170M	$190M
Total Life-cycle Cost, Present Value [b,c]	$145M	$315M	$345M
Life-cycle Unit Cost ($/AF) [a, b,c,d]	$1,700/AF	$5,400/AF	$5,900/AF

a. *The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50% to +100%. In developing preliminary (10%) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30% to +50%). Values are rounded up to the nearest $5 million for capital costs, $100,000 for annual O&M costs; and $100 for life-cycle unit costs. All costs are presented in 2019 dollars.*

b. *ROC management is not included in summary costs. See portfolio descriptions in Section 3 for information on ROC management costs as estimated in the Evaluation of ROC Management Options Final Report (Valley Water, 2020).*

c. *NPR+ distribution system for Option 1 is included in capital and O&M costs but not R&R costs. Lifecycle costs therefore do not reflect R&R costs for the NPR+ distribution system.*

d. *Lifecycle unit cost for Option 1 is based on the high end of the supply yield range.*

Portfolio Evaluation and Risk Assessment Tool

The Master Plan explores various reuse strategies and is not intended to result in selection of a single recommended project. Thus, the Project Team created two tools to compare portfolios: an evaluation tool and a risk tool. The evaluation tool is used to compare portfolios relative to one another with respect to prioritization criteria identified by Valley Water and its Partner Agencies. Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. The risk tool assesses the likelihood and consequence of each risk and compiles them into a composite risk score for each portfolio.

The evaluation tool compares the North County Portfolios with respect to quantitative criteria (e.g., costs, volume of PR water produced, and energy use), as well as qualitative criteria that were based on benefits and/or risk avoidance. NPR/NPR+ expansion and South County Reuse Options were evaluated separately, as these elements can be added to any portfolio.

Based on five criteria—economics, supply reliability, environmental benefits, ease of implementation, and engineering feasibility—Portfolio 1a scores highest regardless of criteria weighting scenarios and is the most "balanced" portfolio: it received some points for all criteria. The scores for Portfolios 1b, 1c, 1d, and 2a were the next highest scoring portfolios, though their scores were not well-balanced (meaning these portfolios performed very well for some criteria but not for others). For example, if more weight is given to the ease of implementation criterion, Portfolio 2a does well (nearly tied for second place with Portfolio 1b) due to an existing long-term flows agreement between Valley Water and Palo Alto. However, if economics receives the most weight, Portfolio 1c comes in second place with Portfolio 1b and 1d following closely behind.

Appendix A-7: Evaluation and Risk Tool provides detailed descriptions of the approaches for developing the tools and how the project team uses them to compare portfolios.

Section 1: Introduction

A reliable supply of clean water is necessary for the environmental, economic, and social well-being of Santa Clara County (County). On behalf of the community, the Santa Clara Valley Water District (Valley Water), along with local partners, have made significant investments to manage demands for water as well as to develop water supplies and infrastructure to meet the County's water needs. As demands continue to grow and future supplies become more uncertain due to climate change, Valley Water intends to continue expanding these partnerships to develop locally controlled, drought-resilient supplies, such as water reuse.

Valley Water's Water Supply Master Plan 2040 (WSMP) recommends investment decisions to meet the County's 2040 water supply reliability goals in a cost-effective manner. One of the key strategies in the WSMP is expansion of water conservation and water reuse. These types of programs offer multiple benefits, including being locally controlled and drought-resilient, and are generally well supported by the community.

Valley Water's Board of Directors has established a goal to increase recycled water use from 18,000 acre-feet per year (AFY) as of 2018, such that water reuse meets 10% of total Countywide demands by 2025. As a result, the WSMP identified a goal of developing an additional 24,000 acre-feet per year (AFY) of reuse capacity, specifically potable reuse (PR) capacity, by 2028 (Valley Water, 2019b).

To assist in meeting these goals, Valley Water initiated development of the Countywide Water Reuse Master Plan (Master Plan; also referred to as the *CoRe Plan*) to integrate existing recycled water plans and infrastructure in partnership with four existing recycled water distribution systems serving non-potable reuse (NPR) in the County, referred to as Partner Agencies and including the following:

- **South Bay Water Recycling (SBWR).** Spanning multiple cities, the SBWR system has a more complex governance structure. Tertiary treated recycled water produced at the San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF) is blended with advanced treated water produced at Valley Water's Silicon Valley Advanced Water Purification Center (SVAWPC). SBWR delivers this blended recycled water to the SBWR distribution system and wholesales it to four retailers: (1) the City of Milpitas, (2) the City of Santa Clara, (3) SJ Muni, and (4) San Jose Water (SJW).
- **Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS).** The Palo Alto Regional Water Quality Control Plant (WPCP) treats wastewater from the communities of Los Altos, Los Altos Hills, Mountain View, Palo Alto, Stanford University, and the East Palo Alto Sanitary District (EPASD) and sends tertiary treated recycled water to the PA/MV RWS. Palo Alto and Mountain View each distribute retail recycled water to customers within their city limits.
- **City of Sunnyvale.** The City of Sunnyvale manages the Sunnyvale recycled water program, which consists of production/operation, distribution, permitting, and monitoring of the Sunnyvale RWS. Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for select service from the Wolfe Road pipeline where Valley Water is the wholesaler and California Water Service Company (Cal Water) is the retailer.
- **South County Regional Wastewater Authority (SCRWA).** SCRWA is a joint powers authority created by the cities of Gilroy and Morgan Hill to manage wastewater treatment. An agreement among SCRWA, Valley Water, and the cities of Gilroy and Morgan Hill establishes SCRWA as the NPR producer, Valley Water as the wholesaler, and the cities of Gilroy and Morgan Hill as the retailers. The City of Gilroy currently retails recycled water. Recycled water facilities are not yet within Morgan Hill.

The Master Plan will provide a framework to make collaborative decisions and implement integrated actions to increase the region's water supply reliability through water reuse, as applied to a planning horizon through 2040. Objectives of the Master Plan include:

1. **Determine reuse supply availability and benefits.** Identify sources and amounts of water available for reuse; the appropriate split between NPR and PR; and regional, Valley Water, and local-level benefits from NPR and PR.

2. **Evaluate potential regional integration.** Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.
3. **Guide system expansion through interagency agreements and governance.** Analyze the economics of project alternatives and explore cost-sharing opportunities.
4. **Solicit input and generate regional support for the Master Plan via coordination and stakeholder outreach.** Improve public perception of water reuse through outreach programs.

The Master Plan will present several portfolios of potential future projects, along with related information that may support potential future interagency agreements and governance.

This Feasible Project Portfolios Technical Memorandum (TM) is an interim deliverable that builds on the Conceptual Alternatives TM (Appendix F), which assessed five portfolios and identified three to carry forward for feasibility analysis. This TM further defines project elements—essentially the building blocks of the three portfolios—to a preliminary (10%) design level and serves as a critical foundation for the Master Plan.

The portfolios are each composed of sets of project elements in two general categories: conveyance/distribution facilities (i.e., pipelines and pump stations) and treatment facilities. The treatment facilities are distinguished by the following characteristics:

- **Source water.** Origin (agency/facility) of wastewater for reuse.
- **Treatment level.** Extent of treatment, based on type of reuse (e.g., NPR, groundwater recharge [GWR], surface water augmentation [SWA], raw water augmentation [RWA], or treated water augmentation [TWA]).
- **Delivery point.** Facility/location where treated product water would be delivered for reuse (NPR or PR).

To assess the three portfolios, the portfolios were evaluated by comparing them to one another based on the following criteria:

- **Economics**, including a comparison of each portfolio's total unit cost (e.g., cost per acre-foot [$/AF]) reflecting capital, operations and maintenance (O&M), and replacement (over an extended time period) costs of new treatment and conveyance facilities; estimated 30- and 100-year life-cycle costs as a present value; funding capability; and grant funding eligibility.
- **Groundwater management and countywide supply reliability,** including a comparison of each portfolio's potable reuse water supply (AFY) based on 2040 estimated flows and design capacity; the number of delivery points included in the portfolio; seasonality of PR supply and delivery point capacity; the dry year drought reliability; and the ability to protect groundwater basin quality.
- **Environmental benefits/impacts and sustainability,** including energy consumption, used as a proxy for reducing carbon footprint and greenhouse gas (GHG) emissions; environmental protection, from a discharge and ROC management perspective; and environmental protection, from a more general California Environmental Quality Act (CEQA) and National Environmental Protection Act (NEPA) perspective.
- **Ease of implementation and permitting/regulatory considerations,** including each portfolio having willing partner(s) interested in collaborating, providing ownership of wastewater, offering operational simplicity, minimizing difficulty in obtaining permits for PR, minimizing difficulty in obtaining permits for environmental regulations (including ROC management and CEQA), being ready to proceed/reducing delays, gaining public acceptance/support, and supporting environmental and social justice/equity.
- **Engineering feasibility,** including using tested and proved technology, and meeting other water quality requirements without difficulty, such as source control and/or monitoring requirements.

Additionally, risk avoidance is built into the evaluation criteria, as several sub-criteria (included in bolded criteria listed above) represent ways of minimizing or avoiding risk rather than providing direct benefits.

1.1 Types of Reuse

The portfolios described in this TM include the following types of reuse.

- **NPR.** NPR systems in the County provide Title 22 disinfected tertiary recycled water for non-potable beneficial uses, such as landscape irrigation and industrial cooling.
- **Enhanced NPR, also referred to as NPR+**. To improve the quality of Title 22 recycled water for such uses, recycled water can be enhanced by blending with purified water (RO treated or equivalent water quality).
- **Indirect Potable Reuse (IPR).** Characterized by use of an environmental buffer prior to becoming a potable water supply, IPR can be accomplished through **GWR** via surface spreading, GWR via direct injection, or **SWA**. While all three forms of IPR are currently regulated in California, Valley Water is not considering GWR via direct injection at this time, based on findings from the Expedited Purified Water Program Plan that indicate unfavorable O&M requirements.
- **DPR.** Defined by the absence of a significant environmental buffer prior to becoming a potable water supply, DPR is accomplished through **RWA** or **TWA**. DPR projects have significantly reduced time to detect and respond to failures or compromises in treatment prior to distribution. Regulations for DPR are being developed and are anticipated by December 2023.

1.2 Regulatory Setting

Given the wide range of reuse scenarios considered in the Master Plan, a spectrum of permitting requirements applies. While source water quantity, intended end uses, and production goals have shaped the portfolios, permitting requirements will likely drive treatment process selection and other considerations, such as degree of wastewater treatment; monitoring and response capabilities; source-control program requirements; and technical, managerial, and financial capacities. The Regulatory Framework TM (Appendix B-2) provides a detailed overview of the regulatory framework for various types of reuse in California, and the following sections summarize the permitting requirements that shaped the treatment process designs in this TM. The Master Plan will include recommended strategies for regulatory compliance for the portfolios.

1.2.1 Environmental Requirements

Regional Water Quality Control Boards (Regional Boards) implement water quality planning and regulatory decisions for their specific regions, such as: issuing waste discharge requirements (i.e., discharge permits), administering National Pollutant Discharge Elimination System (NPDES) permits for receiving surface water bodies, and enforcing Salt and Nutrient Management Plan (SNMP) requirements for groundwater protection.

NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent. The San Francisco Bay (SF Bay) Regional Board (SF Bay; Region 2) regulates discharge facilities in the northern part of County (North County), while the Central Coast (CC) Regional Board (CC; Region 3) regulates SCRWA's discharges in the South County. Regional Boards are responsible for specific regulatory responsibilities affecting water reuse, such as:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing water reclamation (reuse) requirements to producers and users
- Defining beneficial uses of surface water and groundwater bodies through water quality control plans
- Regulating treatment facility operators
- Determining water rights regarding reuse

In context of the Countywide program, the need to seek new or modified NPDES permits through Regional Boards may be triggered by contemplated actions involving one or more of the following discharge scenarios:

(a) purified water discharged to spreading basins for GWR; (b) purified water discharged to Anderson Reservoir for SWA; and/or (c) RO concentrate (ROC) discharged through surface water outfalls.

Most PR applications in California use full advanced treatment (FAT), producing significant volumes of ROC that may contain concentrated levels of total dissolved solids (TDS), nutrients, metals, and toxicity. Depending on the circumstances, reuse projects that discharge ROC to surface water may require a new NPDES individual permit, a modification of an existing NPDES permit, or an industrial permit if discharged into an existing sewer system. The latter would require coordination and agreement with the municipality that manages the respective sewer system. Routing ROC streams to existing outfalls requires careful review of potential impacts to existing NPDES permits to determine whether the ROC stream may compromise compliance with effluent discharge water quality requirements and whether further waste stream treatment and/or permit modifications are needed.

Other ROC management strategies, such as deep well injection or evaporation ponds, trigger a waste discharge requirement permit. Like discharges to surface water bodies, these ROC streams also need to comply with the applicable Basin Plan requirements.

SNMPs establish pertinent water quality objectives (WQO) to protect groundwater quality from potential degradation. NPR for irrigation has the potential to increase salts and other contaminants in groundwater, though it is not expected to be a significant source of salt loading relative to other sources.

1.2.2 Potable Reuse

Permitting requirements differ across specific types of PR. In many cases, these differences are linked to the existence and size of an environmental buffer. As the buffer diminishes in size—or is eliminated in many DPR scenarios—regulatory requirements for other project components increase. Environmental buffers provide myriad benefits—less stringent wastewater and advanced water purification facility (AWPF) treatment requirements (due to the attenuation of contaminants in the environment), dilution to minimize potential chemical contaminant peaks, and/or decreased monitoring requirements due to increased response time.

The least direct form of PR—GWR via surface spreading or direct injection—has been practiced in California the longest, with the first successful IPR project starting in 1962. More than 50 years later, in 2014, the State finalized GWR regulations. The extended period between initial GWR implementation and final regulations provided regulators an opportunity to learn how to protect public health while fostering the growth of this alternative water supply. Recently finalized in 2018, SWA regulations developed more quickly, yet still benefited from the lessons learned and process of developing GWR regulations.

The variation in SWA regulations exemplifies how current regulations require increasing levels of treatment with smaller environmental buffers. As dilution and retention time in a reservoir decreases, pathogen log reduction values (LRV) increase, highlighting the link between the required level of treatment and amount of protection the environment provides. Pathogen reduction requirements can help determine treatment process selection and, therefore, have a large impact on AWPF design decisions. For example, additional advanced treatment processes are included to account for protections lost by minimizing time between treatment and consumption.

Figure 1-1 summarizes the forms of potable reuse and their minimum requirements as dictated by state regulations. As the environmental buffer becomes less significant—providing less dilution and/or retention time—the LRVs required increase for the target pathogens, including viruses, *Giardia* cysts, and *Cryptosporidium* oocysts (V/G/C).

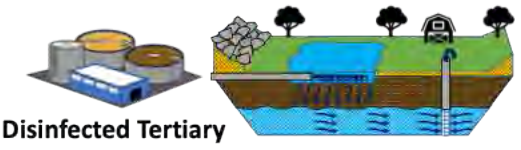
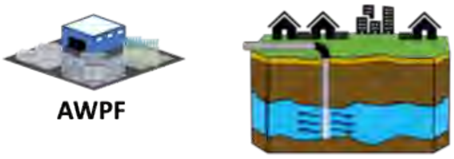
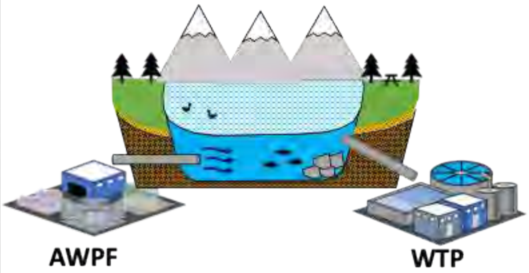
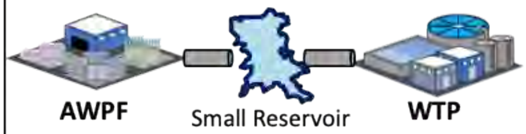
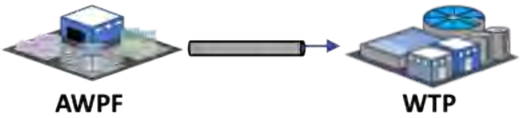
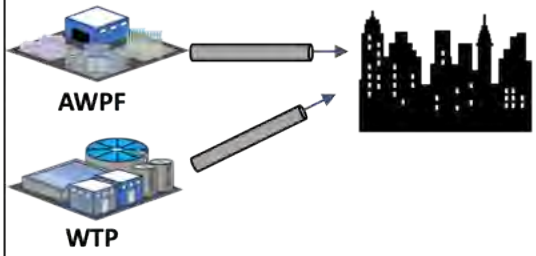
	Configuration	LRV Requirements V/G/C	Additional Considerations
Indirect Potable Reuse	**Groundwater Recharge – Surface Spreading** 	**12/10/10** • Retention time typically ≥ 6 mos.	• Final regulations in 2014 • Does not require FAT • Typically relies on aquifer for V/G/C credit and additional chemical control
	Groundwater Recharge – Direct Injection 	**12/10/10** • Retention time ≥ 2 mos.	• Final regulations in 2014 • Requires FAT train • Typically relies on aquifer for virus credit
	Surface Water Augmentation 	**12/10/10** • Min. dilution 100-to-1 • Reservoir V/Q > 4 mos. **13/11/11** • Min. dilution 10-to-1 • Reservoir V/Q > 4 mos. **14/12/12** • Min. dilution 10-to-1 • 4 mos. > V/Q > 2 mos.	• Final regulations in 2018 • Requires FAT train • No pathogen credits for reservoir storage
Direct Potable Reuse	**Raw Water Augmentation** 	**TBD**	• Final regulations in 2023 • Likely to require FAT plus additional treatment • Additional requirements anticipated for source control, wastewater treatment, chemical control, monitoring, operations, blending, diversions, and other topics.
		**TBD**	
	Treated Water Augmentation 	**TBD**	

Figure 1-1. Summary of PR forms and associated pathogen reduction requirements

In general, the requirements for the control of toxic chemicals are equivalent across the various forms of IPR, with the GWR and SWA regulations requiring both effluent monitoring to verify compliance with all regulated chemicals and a suite of unregulated contaminants (including constituents of emerging concern [CEC]), as well as surrogate monitoring to confirm treatment train performance. The requirements for chemical monitoring continue to evolve, including the notable recent addition of a bioassay requirement in the State Water Resources Control Board's (State Board) Recycled Water Policy. The FAT train meets these requirements for many IPR applications and provides treatment for specific chemicals.

In DPR—including both RWA and TWA—the environmental buffer may be significantly reduced or eliminated compared to IPR. Consequently, there may be enhanced requirements for pathogen control, chemical attenuation, real-time monitoring, engineered storage, and blending (Figure 1-1). Though regulations for RWA and TWA have not yet been developed, potential future requirements can be inferred from recent publications and presentations from the State Water Resources Control Board's Division of Drinking Water (DDW), the California DPR Expert Panel, and the Project Team's engagement in DPR research and permitting. A more in-depth evaluation of regulatory compliance for the portfolios' potable reuse elements is included in the Master Plan's Appendix B-1.

Under legislative mandate in Assembly Bill (AB) 574, the State Board is required to develop regulations for RWA by the end of 2023 (with a potential extension to mid-2025). In August 2019, the State Board issued the second edition of its Proposed Framework for Regulating DPR in California, with various updates to their initial draft.

Notably, the State Board has indicated the intent to develop a single DPR regulatory package that encompasses requirements for both RWA and TWA. The timeline for the DPR regulatory package remains consistent with the AB 574 deadline of December 2023. In marked contrast with earlier potable reuse regulations, the revised DPR regulations will require treatment to consistently meet a daily risk objective versus an annual risk objective. This shift will likely increase the LRV requirements for DPR applications, though the specific criteria are still under development.

Currently, the State Board is funding priority DPR research topics to address knowledge gaps identified as critical for regulatory development. Leveraging this research, the State Board has also indicated that it will set DPR regulations focused on "…ensur[ing] the public's health is reliably protected at all times." These considerations will impact the design of various elements in the feasible project alternatives—from source control to treatment, monitoring and operations, diversions, and alternative supplies (Table 1-1).

Table 1-1. Approaches to maintain public health protection in DPR settings

Approach	Description
Source Control	Source control is a management barrier that provides a first layer of protection against toxic chemicals. It controls chemical risks by reducing concentration and variability of chemicals entering an AWPF. Compared to IPR, more stringent source control requirements will apply to DPR due to lack of an environmental buffer.
Wastewater Treatment	Consistent AWPF performance is enabled by upstream wastewater treatment that provides a consistently high-quality feedwater to AWPFs. The State Board and DPR Expert Panel recommend minimum criteria for wastewater treatment plants (WWTP) serving as source water to a DPR system, including a high degree of organics destruction (e.g., secondary processes providing biological nutrient removal) and tertiary filtration prior to the AWPF.[a b c] Other beneficial elements include management of flows into the system and rigorous process monitoring.
Pathogen Control	Pathogens represent the most important public health concern because a single exposure can result in a public health impact. The State will require additional redundancy in pathogen control for DPR, possibly extending beyond IPR requirements and based on complying with a daily risk goal (instead of annual risk goal used for IPR). Barriers include treatment and management (non-treatment) approaches.
Chemical Control	DPR trains will likely need to provide additional control measures—including treatment—to attenuate chemical peaks and provide added protection against compounds known to pass through FAT trains[a] and unknown compounds with similar characteristics.
Response Time and Failures	In IPR settings, an environmental buffer enables more time for identifying failures and responding appropriately. With DPR retention time being hours (not months), DPR requires moving toward greater failure prevention and configuring elements of a DPR system—including monitoring, diversions, storage, treatment, automated controls, and operator training—to achieve a balance that protects public health without much failure response time.

a. *State Water Resources Control Board (2016)*
b. *State Water Resources Control Board (2019)*
c. *Tchobanoglous et al (2015)*

1.3 Environmental Setting

Following development of the Master Plan, Valley Water intends to prepare a programmatic Environmental Impact Report (EIR) to describe the environmental impacts of the project elements and portfolios. This approach affords an approval process that gives the flexibility to proceed with implementing individual project elements or portfolios.

Some environmental factors—such as GHG emissions, energy use, and discharge water quality, quantity, location, and timing—vary across project portfolios due to the number and size of proposed AWPFs, length of pipelines, pumping requirements, ROC management strategies, and other factors. At this current planning-level phase, other CEQA-required considerations are generally consistent among portfolios, including biological resources, geology, soils, fisheries, land use, cultural resources, noise, air quality, traffic, hazardous materials, aesthetics, economic justice, and growth inducement. As more information becomes available about each project portfolio, other CEQA-required considerations may become differentiators when a programmatic EIR is being prepared.

Section 2: Project Elements

This section summarizes preliminary (10%) design details of the project elements, including treatment facilities, conveyance/distribution facilities (i.e., pipelines and pump stations), delivery point improvements (e.g., LGRP piping), and conceptual cost estimates. More detailed information on elements to complement this section is included in other appendices, as follows.

- Appendix A-2: Compendium of flow assessments, facility design capacity, and annual yield calculations
- Appendix A-3: Treatment facilities' design criteria and sizing calculations
- Appendix A-4: Process flow diagrams and site layouts
- Appendix A-5: Basis of costs for project elements (i.e., inputs, assumptions, methods, and sources)
- Appendix A-6: Conceptual estimates for project elements' costs (i.e., line-item costs for AWPFs, pump stations, pipelines, and system interties)
- Appendix A-7: Expanded evaluation and risk assessment
- Appendix A-8: TWA Pre-screening analysis
- Appendix A-9: Onsite Reuse TM
- Appendix A-10: San José Flex Implementation TM
- Appendix A-11: Palo Alto Flex Implementation TM
- Appendix B: Regulatory compliance
- Appendix C: Hydraulic modeling
- Appendix D: Project definition, roles, and responsibilities
- Appendix E: Baseline analysis
- Appendix F: Conceptual alternatives
- Appendix G: ROC management strategies reference files

Cost estimates were developed using information from vendor quotes specific to proposed facilities, historical construction estimates and cost data, and professional experience with similar projects. Capital costs include construction-related materials and equipment costs, tax, contractor overhead and profit, owner's reserve for change orders, construction management, and engineering services for design and construction. The O&M costs include consumables (such as membranes, ultraviolet (UV) lamps, UV ballasts, and decarbonator tower media), energy/power, chemicals, and labor.

The scope of this project includes Class 5 cost estimates. Per AACE International's criteria, expected accuracy for Class 5 estimates typically ranges from -50% to +100%. In developing preliminary (10%) designs, the Project Team collected quotes from equipment manufacturers for the AWPFs' treatment process systems, increasing the level of accuracy of AWPF costs consistent with Class 4 estimates (-30 to +50%).

2.1 Treatment Facilities

The reuse treatment facilities are distinguished by the following characteristics:

- **Source water.** Origin (agency/facility) of wastewater for reuse.
- **Treatment level/type of reuse.** Extent of treatment, based on type of reuse; types of reuse considered for project elements in this TM include NPR, NPR+, GWR via surface spreading, SWA, RWA, and TWA.
- **Delivery point.** Facility/location where treated product water would be delivered for reuse (NPR or PR).

Partner Agencies produce recycled water for NPR at existing treatment facilities, and each have established plans for continued future use. As such, the treatment elements explored in this TM include AWPFs for NPR+, GWR, SWA, RWA, and TWA as summarized in Table 2-1.

Table 2-1. Project Elements: Treatment Facilities

Description	Source Water Facility(ies)	Type of Reuse	Delivery Point	Design Capacity (mgd)[a]	Treatment Processes
San José AWPF (pending future NPR+ demands and potential source of Morgan Hill NPR+)	SJ/SC RWF	NPR+	SBWR distribution system	8	Microfiltration (MF), RO, UV (FAT process)
San José AWPF	SJ/SC RWF	GWR	LGRP	24	FAT process
San José AWPF	SJ/SC RWF	RWA	Penitencia Water Treatment Plant (WTP) (as operations require, LGRP and Rinconada WTP are supplemental delivery points)	24	FAT process plus ozone-biologically active carbon (O_3-BAC)
San José AWPF	SJ/SC RWF	TWA	Conveyed using either the Milpitas Pipeline or a new pipeline to the treated Piedmont Valve Yard at Penitencia WTP	24	FAT process plus O_3-BAC and chlorine disinfection
Local Palo Alto AWPF	Palo Alto RWCQP	NPR+	PA/MV RWS distribution system	2.25	Microfiltration/ultrafiltration (MF/UF), RO, disinfection
Local Sunnyvale AWPF (if intertied to PA and SBWR)	Sunnyvale WPCP	NPR+	Sunnyvale RWS distribution system	1.2	MF/UF, RO, disinfection
Combined Regional AWPF in Palo Alto (former LATP site)	Palo Alto RWQCP and Sunnyvale WPCP	GWR	Los Gatos Recharge Ponds (LGRP)	24.5 (24 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Combined Regional AWPF in Sunnyvale (Recycle Hill site)	Palo Alto RWQCP and Sunnyvale WPCP	GWR	LGRP	24.5 (24 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Separate Regional AWPF in Palo Alto (former LATP site)	Palo Alto RWQCP	GWR	LGRP	14	FAT process with equalization basin
Separate Regional AWPF in Sunnyvale (Recycle Hill site)	Sunnyvale WPCP	GWR	LGRP	10.5 (10 for GWR; 0.5 for NPR+)	FAT process with equalization basin
Morgan Hill satellite plant and AWPF	Morgan Hill	GWR and SWA	Anderson Reservoir (for blending, dilution, and subsequent treatment at a Valley Water WTP	2	FAT process with membrane bioreactor (MBR)

a. *Design capacities are for determining feasibility and do not reflect contractual flow agreements. For example, the design capacity of the separate regional AWPF in Palo Alto is listed as 14 mgd, though the contractual agreement between Palo Alto and Valley Water establishes a minimum supply guarantee of 9 mgd for purification at a regional AWPF.*

b. *State Water Resources Control Board (2019)*

2.1.1 Source Water

The project elements and portfolios consider partnerships with the agencies producing NPR from four municipal WWTPs in the County, including:

- SJ/SC RWF
- Palo Alto RWQCP
- Sunnyvale WPCP
- SCRWA

Currently, some portion of wastewater effluent from these facilities is recycled for NPR and, in Palo Alto, sent to wetlands for environmental benefit. Remaining effluent in North County is discharged to the San Francisco Bay, while remaining effluent in South County is sent to percolation ponds or discharged to the Pajaro River (toward Monterey Bay). The feasible portfolios explore options that use a portion of the County's projected remaining effluent as source water for additional reuse (both PR and NPR). In addition, an option being considered for Morgan Hill involves satellite treatment—an approach where raw wastewater would be diverted from the SCRWA collection system.

Table 2-2 summarizes projected influent flow at each WWTP, shown as average dry weather flow (ADWF), or the lowest consecutive three-month average. To account for the uncertainty in future influent projections (e.g., changes in water use/land use and population growth/density), a range of flow is presented. The lower bound assumes influent remains constant, using the average of monthly median flows from 2014 to 2018 as the baseline. The upper bound uses the same baseline but assumes flows increase at the rate projected in individual agencies' wastewater or recycled water master plans through 2035. (In cases where multiple flow projection curves were provided, the flattest slope was selected.)

Table 2-2. Range of Projected 2035 WWTP Influent Flows [a]

	Projected ADWF, using 2014-2018 baseline[b] (mgd)	
WWTP	Lower Bound Projection: Flatline	Upper Bound Projection: Increasing ADWF[c]
SJ/SC RWF	98.4	106
Palo Alto RWQCP	17.7	19.6
Sunnyvale WPCP	11.2[d]	15.9
SCRWA	6.0	6.0

a. Although 2040 is the planning horizon for the Master Plan, 2035 was used for the flow analysis based on projections available in Partner Agencies' planning documents. Using 2035 also provides a more conservative estimate of available flow, since influent will likely remain constant or increase between 2035 and 2040 (according to current projections.

b. ADWF was calculated using average of monthly median flows from 2014-2018. Influent flow data was downloaded from the California Integrated Water Quality System (CIWQS) database.

c. Rate of increase based on slopes from individual agencies' influent projection curves (in past wastewater or recycled water plans)

d. Actual Sunnyvale WPCP influent is approximately 0.5 mgd lower than the values reported in CIWQS, due to a difference in metering location. Values shown in Table 2-1 account for this by subtracting 0.5 mgd from the CIWQS data.

Figures 2-1 through 2-3 show the lower and upper bound ADWF range for the three North County WWTPs in comparison to projections from previous planning studies. Figures 2-1 and 2-2 overlay existing figures from SBWR and Palo Alto, respectively. SCRWA WWTP influent was already projected to remain constant over time (at approximately 6 mgd); so, flatlining the projections makes no significant difference in South County.

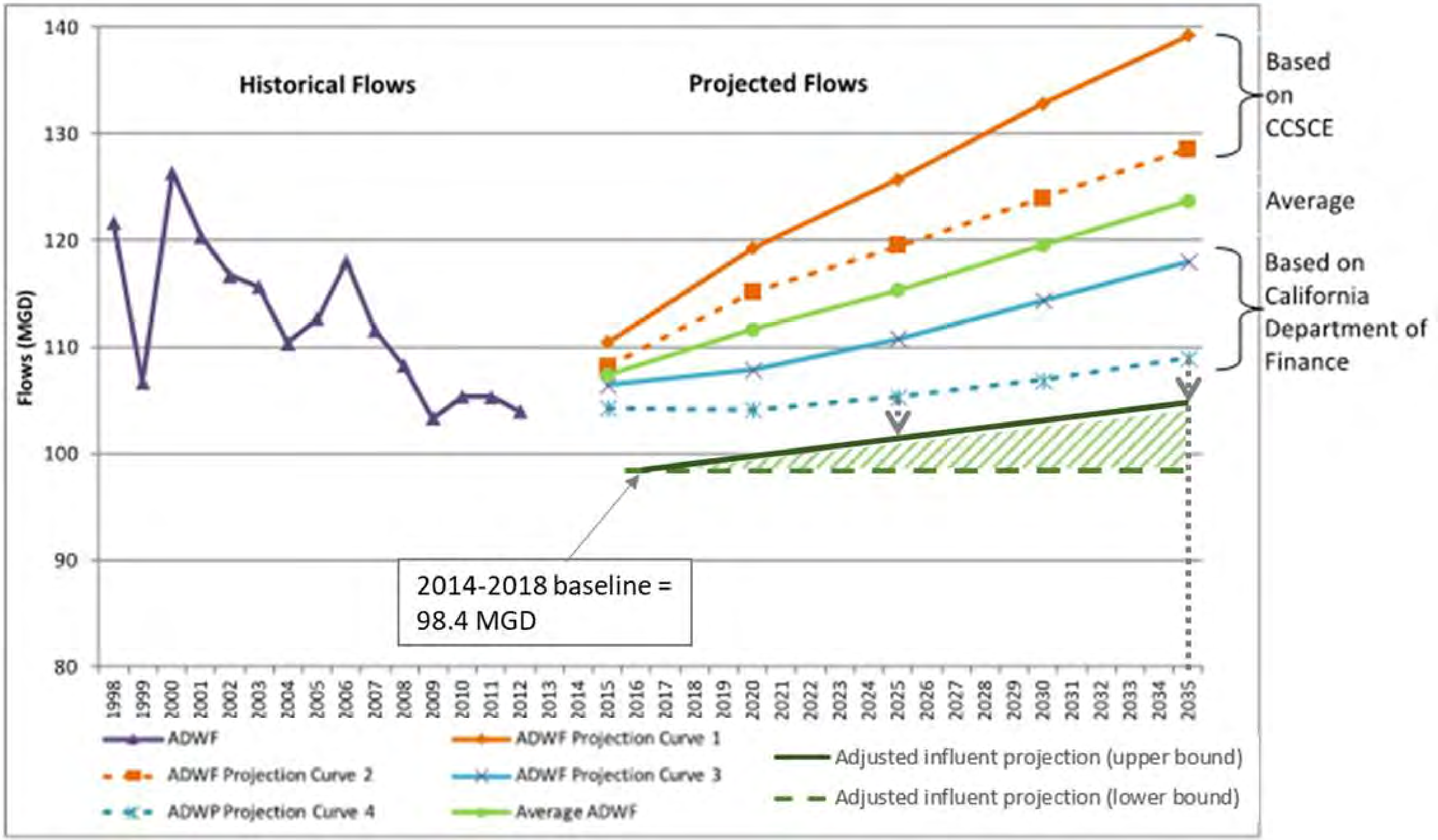


Figure 2-1. Dry-weather influent projections from the SBWR Strategic and Master Planning Report, with adjusted flow range

Source: SBWR, "Strategic and Master Planning Report." December 2014.

Note: The adjusted influent projection lines overlay the original figure from SBWR's Strategic and Master Planning Report.

CCSCE = Center for the Continuing Study of the California Economy

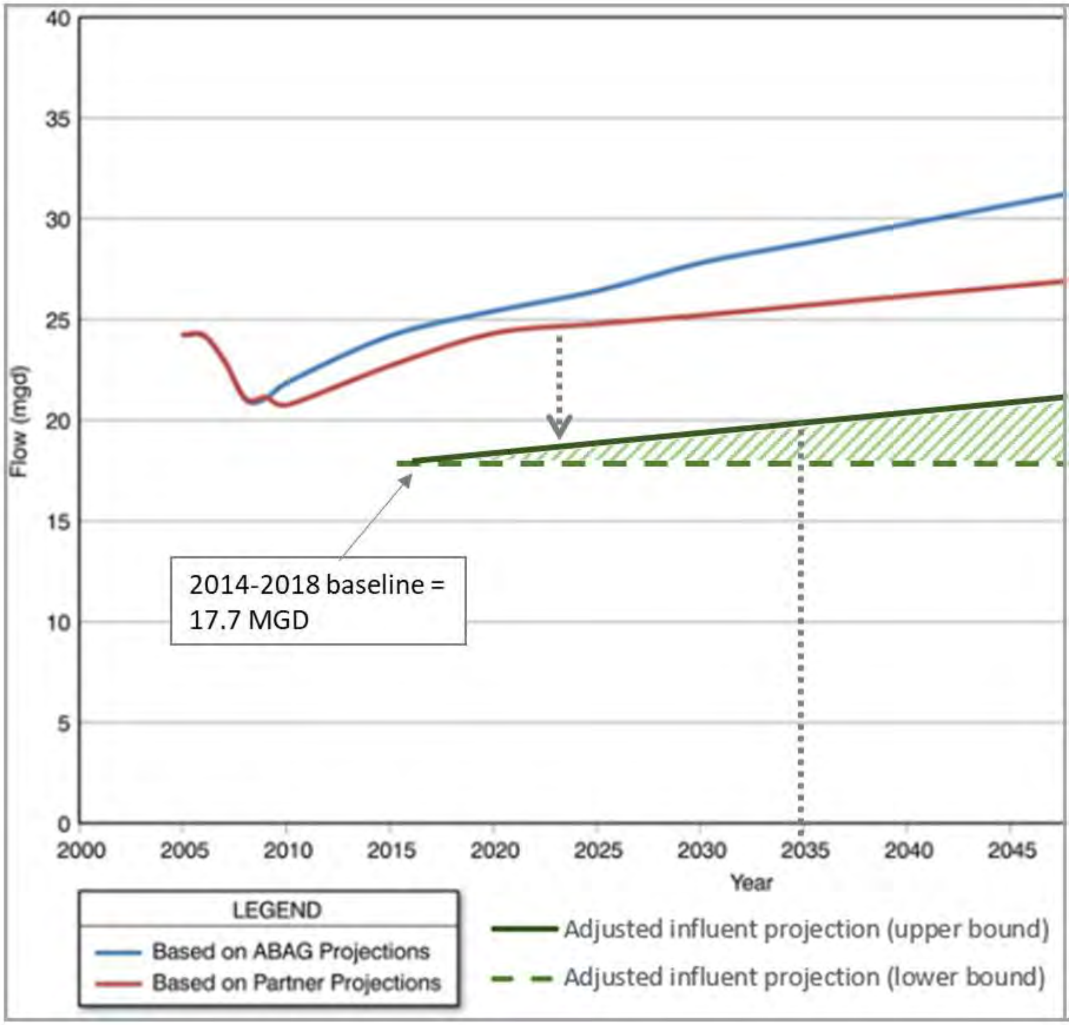


Figure 2-2. Dry-weather influent projections from the Palo Alto Long-Range Facilities Plan, with adjusted flow range

Source: City of Palo Alto, "Long Range Facilities Plan for the Regional Water Quality Control Plant." October 2012.

Note: The adjusted influent projection lines overlay the original figure from Palo Alto's Long-Range Facilities Plan.

ABAG = Association of Bay Area Governments (regional land use and transportation planning agency)

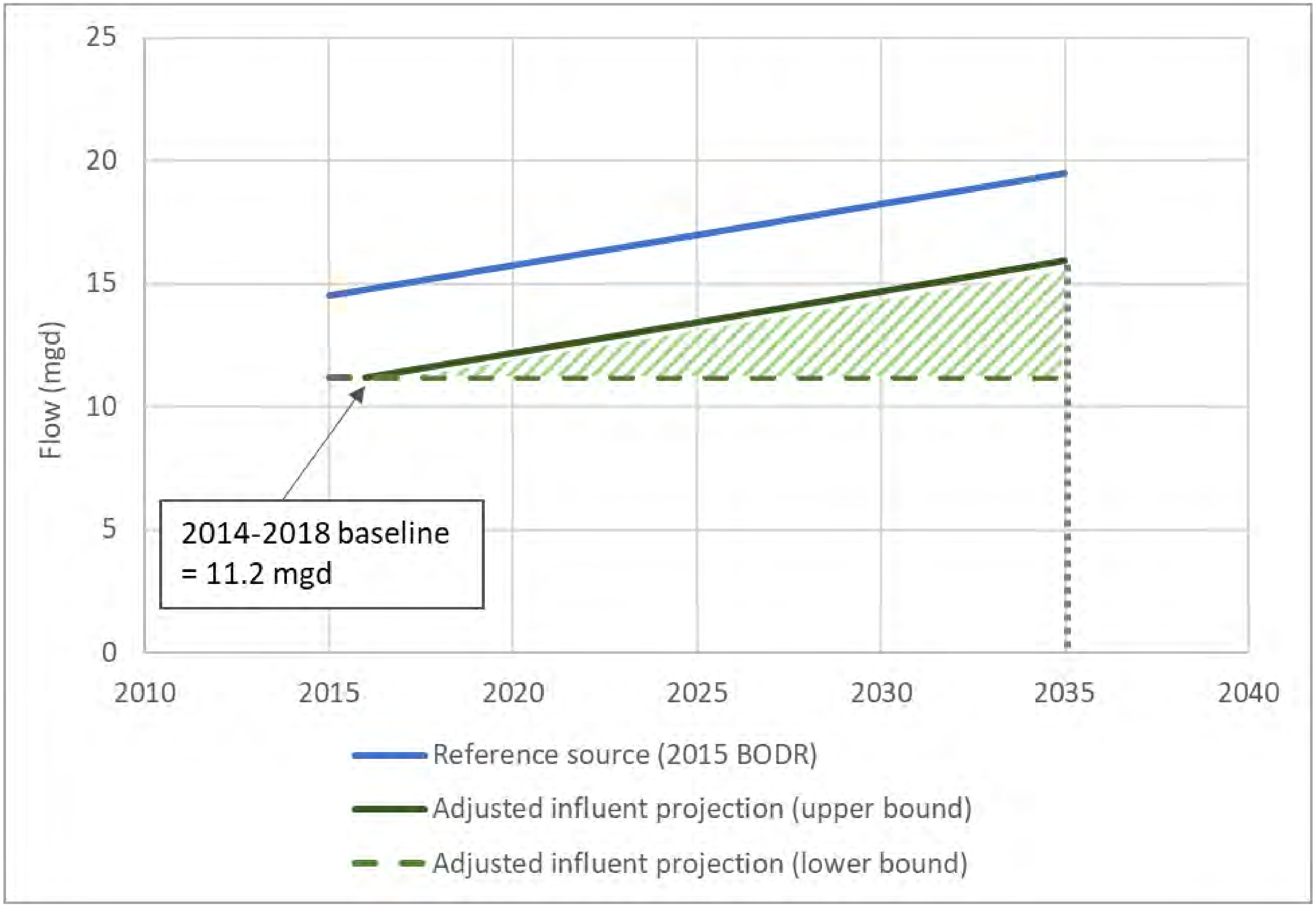


Figure 2-3. Dry-weather influent projections from the Sunnyvale WPCP Basis of Design Report (BODR), with adjusted flow range

Source: City of Sunnyvale, "Simultaneous Production of Recycled Water." Basis of Design Report. July 15, 2015. Prepared by HDR.

Future ADWF was converted to monthly flow projections based on the seasonal variation of historic flows. Using the 2035 lower and upper bound monthly flows, a PR yield evaluation was performed to assess the potential water supply outcome for each facility. The PR yield evaluation accounted for a variety of flow commitments and/or allocations of flow, including:

1. Losses/uses around the WWTP (e.g., Palo Alto RWQCP onsite use, capping at the Sunnyvale WPCP ponds)
2. Environmental flows (e.g., Palo Alto future flows to Renzel Marsh and potentially to horizontal levees)
3. Projected future NPR demand
4. Advanced treatment process losses (i.e., ROC) for NPR+

These commitments and allocations were subtracted from the projected influent to determine the remaining effluent available for PR or other purposes (e.g., discharge, blending). The evaluation considered monthly flow availability, and a sensitivity analysis of AWPF capacities for PR was used to identify AWPF capacity and associated yield at each facility. Table 2-3 summarizes average annual flows and potable reuse yields for each of the North County facilities, based on this evaluation. A more detailed summary of the evaluation, including monthly flows by Partner Agency, is included in Appendix A-2.

Table ES-1. Summary of Projected Annual Flows and Yields

	Annualized Flows Projected for 2035 (mgd)								
	WWTP Influent						Purified Water		
Location	Avg. Dry Weather Flow (ADWF)	Avg. Annual Flow	Avg. Annual Environmental Flows & Misc. Losses	Future NPR Demand	ROC from NPR+	Calculated Net Effluent Remaining [a]	Assumed Production Capacity	Avg. Production	Anticipated Potable Reuse Yield (AFY)
SJ/SC	98.4 - 106	100.5 - 108.2	--	27.6 [d]	1.8 [e]	71 - 78.7	24	21.6 [f]	24,000 [f]
Palo Alto	17.7 - 19.6	19.3 - 21.3	3.3 [b]	2.5	0.2	13.3 - 15.3	14	10.5 - 11.8 [g]	11,700 - 13,200 [g]
Sunnyvale	11.2 - 15.9	11.9 - 16.9	4.0 [c]	1.5	0.1	6.3 - 11.3	10.5	4.9 - 8.8 [g]	5,500 - 9,800 [g]
Morgan Hill	--	--	--	--	--	2.1	2.1	1.7	1,900

a. Calculated Net Effluent Remaining = Avg. Annual WWTP Influent – [Environmental Flows & Misc. Losses + Future NPR Demand + ROC from NPR$^+$]
b. 3 mgd of future flows to Renzel Marsh and potentially to horizontal levees and 0.3 mgd for losses in/around RWQCP (from 2015 Urban Water Management Plan)
c. 4 mgd for evaporation and capping at Sunnyvale's treatment ponds
d. SBWR retailers' future NPR demand, as provided by SBWR staff. Does not include potential future NPR demand in Morgan Hill.
e. ROC stream related to existing Silicon Valley Advanced Water Purification Center (SVAWPC) operating at 8 mgd capacity; used to improve water quality of NPR to meet a total dissolved solids (TDS) target of 500 milligrams per liter (mg/L) year-round.
f. San José AWPF was sized assuming a 90% online factor, due to extent calculated net effluent remaining exceeds the 24,000 AFY goal.
g. Palo Alto and Sunnyvale AWPFs were sized to maximize production of purified water while also maintaining a reasonable AWPF efficiency, based on source flow availability. More details on flow availability and AWPF sizing are included in Appendix A-2.
mgd = million gallons per day

The evaluation shows that the SJ/SC RWF is expected to have sufficient effluent to meet Valley Water's goal of 24,000 AFY for PR. When combined, Palo Alto and Sunnyvale have the potential to yield about 23,000 AFY under the upper bound influent flows. Under the lower bound projection, Sunnyvale and Palo Alto combined has an estimated yield of 17,200 AFY for PR. This lower yield (below Valley Water's goal) is a potential risk for an AWPF dependent on effluent from Sunnyvale or Palo Alto and is considered in the portfolio comparison and analysis (Section 5). Given the limited source water available in Palo Alto and

Sunnyvale, larger facilities would have higher costs with diminishing benefits. Also, the need to meet NPDES permit requirements could affect whether additional effluent needs to be reserved for blending.

In South County, the Morgan Hill satellite option would divert raw wastewater from a trunk sewer in Morgan Hill. Based on SCRWA WWTP influent flow data, the Morgan Hill trunk sewer is assumed to carry approximately 2.5 mgd of wastewater, on average. However, flow fluctuates seasonally, and in the summer months some of this flow may be needed to meet NPR demands in Gilroy. Subtracting out the wastewater needed to meet NPR demands in Gilroy, the average annual flow available for advanced treatment in Morgan Hill is approximately 2.1 mgd.

2.1.2 Delivery Point

Delivery points refer to locations where treated water would be conveyed for reuse (NPR or PR). The delivery points considered in this TM, grouped by treated water type, include:

- **NPR/NPR+**: New and existing NPR users throughout the County
- **GWR**: LGRP in North County and a combination of several percolation ponds in South County
- **SWA**: Valley Water’s Anderson Reservoir in South County, near Morgan Hill
- **RWA**: South Bay Aqueduct (SBA) terminal tank at Penitencia WTP
- **TWA**: Local distribution conveyed through new pipelines to the cities of San Jose and Santa Clara (portions north of Highway 101) and through either: (a) the existing Milpitas Pipeline or (b) a new pipeline to the Piedmont Valve Yard for blending with treated water near Penitencia WTP for distribution.

The following sections describe the delivery points for NPR/NPR+, GWR, SWA, RWA, and TWA.

2.1.2.1 NPR/NPR+

The four NPR producers in the County have established plans for expanding their NPR/NPR+ distribution systems, as defined in their individual recycled water master plans and summarized in Section 2.3.1.

2.1.2.2 Groundwater Recharge

LGRP is the sole North County GWR location considered in the three project portfolios. The LGRP complex is one of seven major GWR systems operated and maintained by Valley Water. Located near Los Gatos Creek, the LGRP complex is composed of six pond sets—Camden, Page, Sunnyoaks, Budd Avenue, Oka, and McGlincy—and divided into two systems, Page Ditch and Kirk Ditch. Each system has its own intra-pond conveyance system that delivers water to the individual pond sets. Page Ditch connects the Kirk Diversion Dam to the Camden, Page, Sunnyoaks, and Budd Avenue pond sets, while Kirk Ditch connects the Kirk Diversion Dam to the Oka and McGlincy pond sets.

Valley Water’s *Expedited Purified Water Program Plan, Appendix E* (LGRP Facilities Plan) identified infrastructure improvements to multiple LGRP delivery points to facilitate O&M activities and maintain high recharge rates. While detailed information on these delivery points is included in the LGRP Facilities Plan, Figure 2-4 identifies pipelines to convey purified water to delivery points, including both the existing conveyance main (red line) and proposed pipelines (blue lines), as well as the four delivery points (green triangles) corresponding with the following locations:

- Budd Pond 1
- Sunnyoaks Pond 2
- Page Ditch, upstream of Page Pond 1
- Kirk Ditch near Kirk Diversion Dam

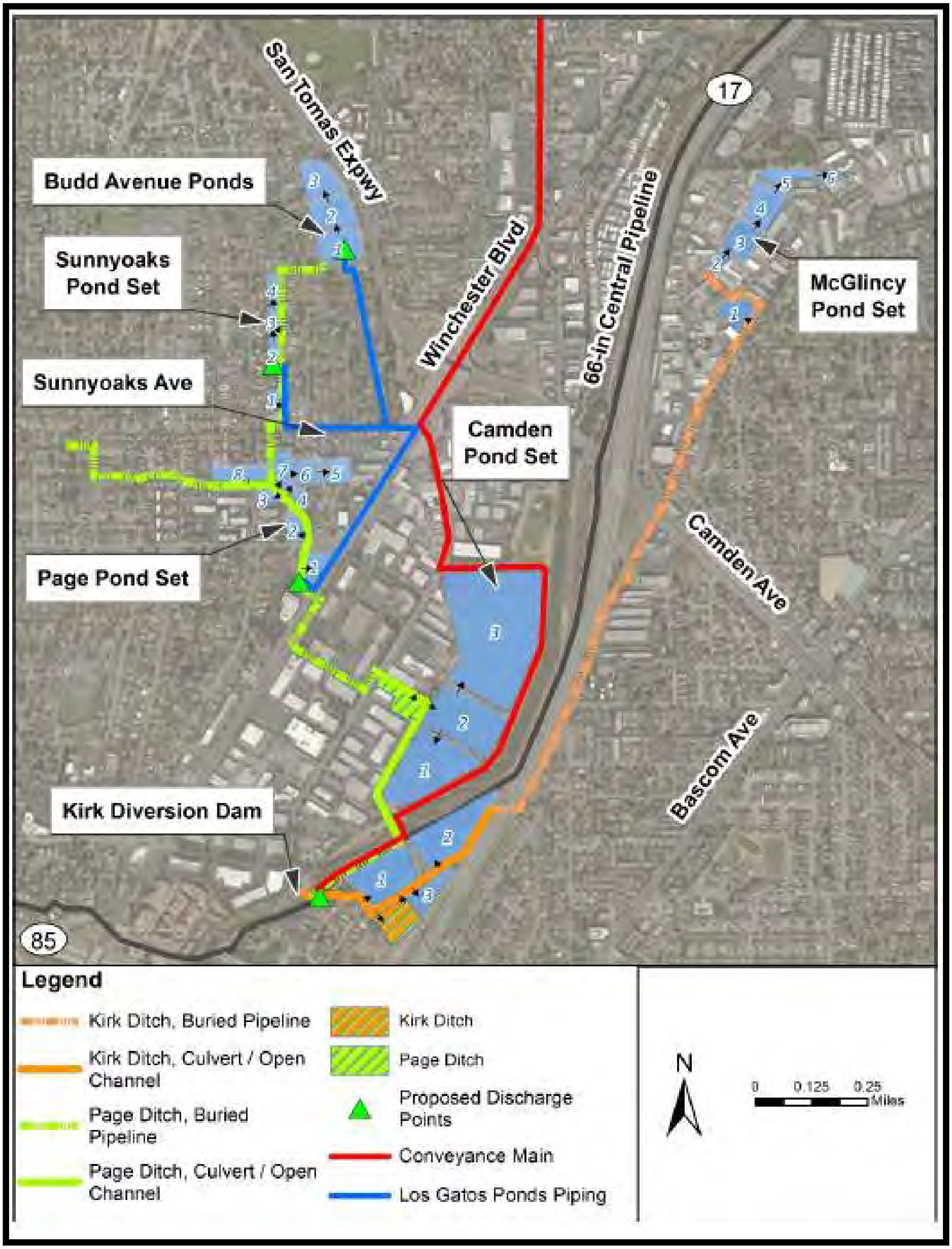


Figure 2-4. LGRP infrastructure improvements

Source: RMC/Woodard & Curran, 2017. Los Gatos Recharge Ponds Facilities Plan; Appendix E to Expedited Purified Water Program Plan.

Note: The conveyance main and LGRP piping are both proposed (future) elements.

Recharge locations in South County are more challenging. Morgan Hill, Gilroy, and unincorporated areas rely on groundwater for potable supply, and wells are distributed throughout the area. Given the close proximity of many active potable wells to percolation ponds contemplated for GWR, the ability to achieve a minimum of two-month underground retention without impacts to wells is not feasible in the region. Any GWR project in the Llagas Subbasin would require decommissioning and possibly replacing existing wells and/or finding suitable replacement water, resulting in higher costs. Because of the challenging recharge conditions, other sites such as Main Avenue ponds or Butterfield Channel (as identified in the 2019 Sustainable Water Management Plan by the Cities of Gilroy and Morgan Hill) should be evaluated further in the event of advancing South County GWR portfolios.

2.1.2.3 Surface Water Augmentation

Incorporating SWA with the Morgan Hill GWR concept may yield water supply benefits while protecting groundwater quality of potable wells. The SWA variation involves pumping purified water from the Morgan Hill satellite facility through a new pump station and pipeline to Anderson Reservoir (Figure 2-5). With a total capacity of more than 89,000 AF, Anderson Reservoir is the largest of Valley Water's 10 surface reservoirs. Supply from San Luis Reservoir and local runoff will substantially dilute purified water treated at a Morgan Hill satellite facility and AWPF. Consistent with current operations, Valley Water will treat the blended supply from Anderson Reservoir at Santa Teresa WTP or Rinconada WTP. (Note: Anderson Reservoir's storage capacity is currently limited to roughly 52,000 AF due to seismic restrictions. The dam is undergoing a seismic retrofit, making the reservoir unavailable for SWA from 2020 to 2027 during construction.)

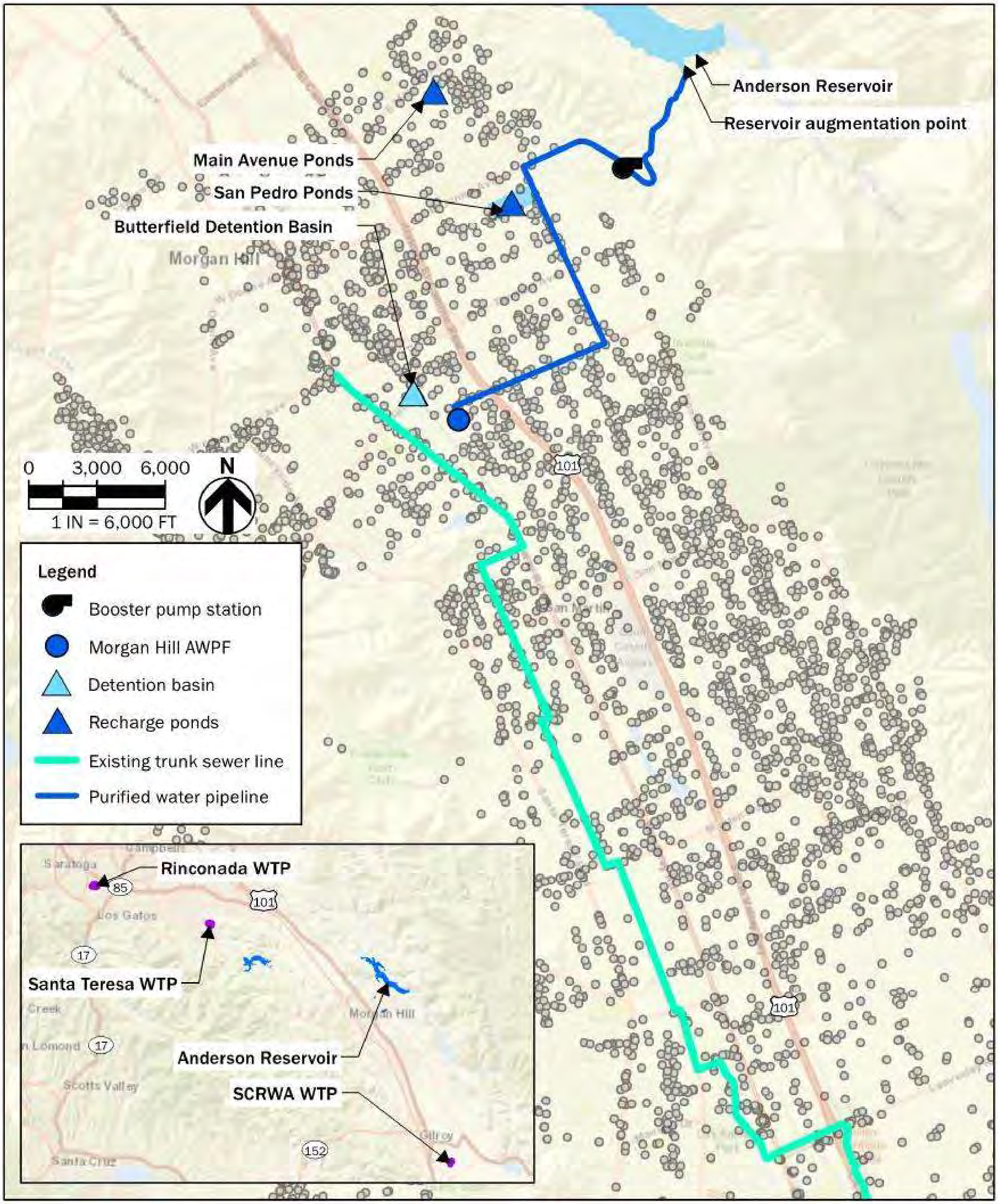


Figure 2-5. Morgan Hill recharge locations

In exchange for contributing supply to Anderson Reservoir, Valley Water would increase deliveries from the Santa Clara Conduit to existing percolation ponds to recharge the Llagas Subbasin. The San Pedro Ponds delivery point is assumed for preliminary design. Further evaluation is needed to determine feasibility of this location and to compare it to other possible sites.

2.1.2.4 Raw Water Augmentation

In the RWA scenario, purified water produced at the San José AWPF would be pumped to a proposed 3-million-gallon (MG) purified water tank sited near the Penitencia WTP—specifically, on a hill above the elevation of the existing SBA terminal tank (Figure 2-6). The 3-MG tank would provide flow rate control to introduce purified water into the existing SBA terminal tank (i.e., the blend point) as a protective measure to manage impacts of potential off-specification (off-spec) raw water. Purified water would blend with SBA flow in the existing SBA terminal tank. From this point, existing infrastructure would allow the blended water to be either treated and distributed from the Penitencia WTP or conveyed from the Penitencia Force Main (FM) to the Central Pipeline as supply to the Rinconada WTP or LGRP. The latter supports alternative delivery points when Penitencia WTP is operating near its capacity (40 mgd) and cannot treat additional supply. Routing purified water through the Central Pipeline allows access to Rinconada WTP, which has a total production capacity of 80 mgd, with planned improvements to increase capacity to 100 mgd by 2021. Figure 2-7 demonstrates monthly average production at these two WTPs. More details on the proposed delivery points for RWA can be found in Appendix C of Valley Water's *Expedited Purified Water Program Plan* (RMC/Woodard & Curran, 2018b).

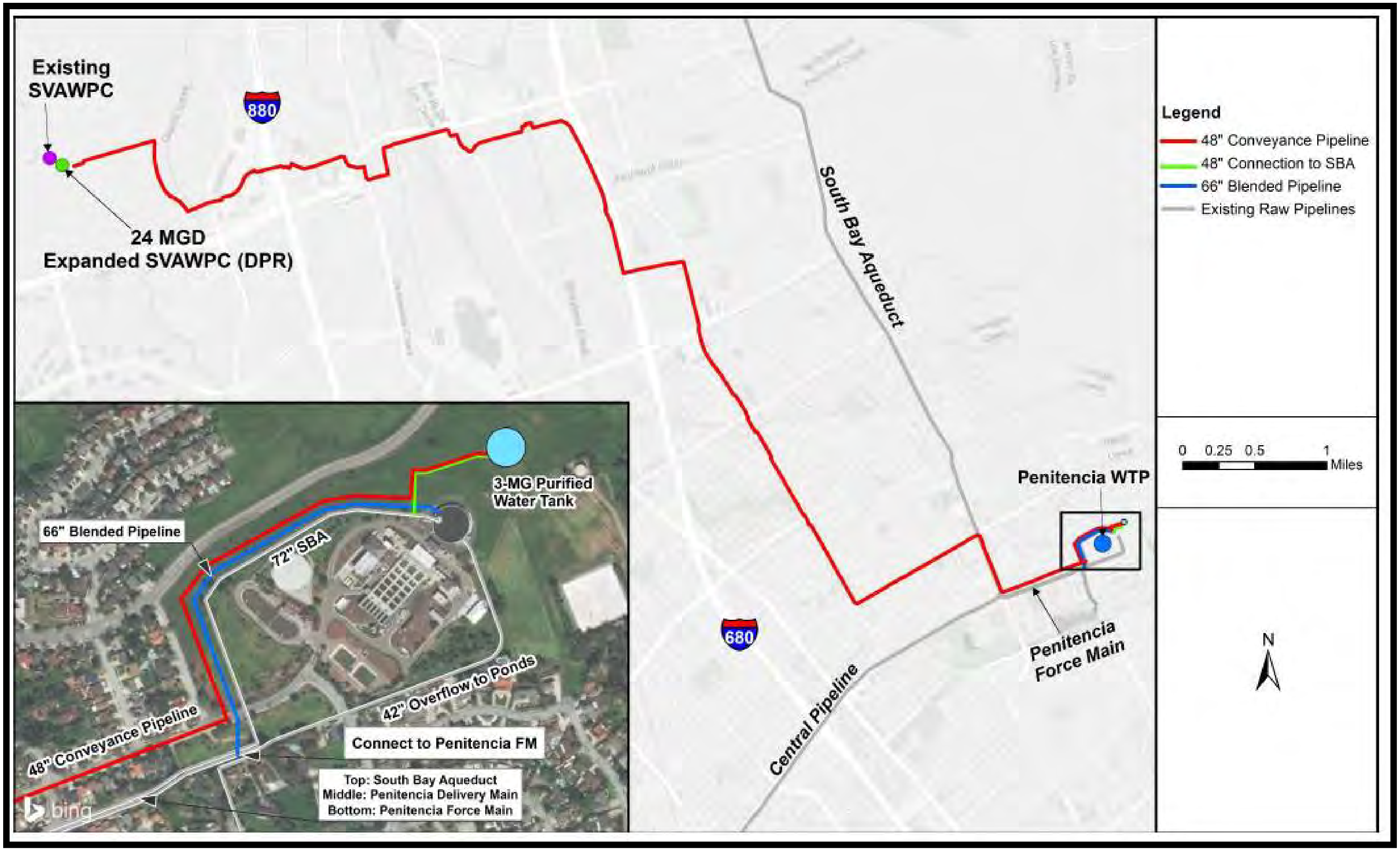


Figure 2-6. RWA delivery point facilities (Penitencia WTP) and improvements

Source: RMC/Woodard & Curran, 2018b. Direct Potable Reuse Facilities Plan; Appendix C to Expedited Purified Water Program Plan.

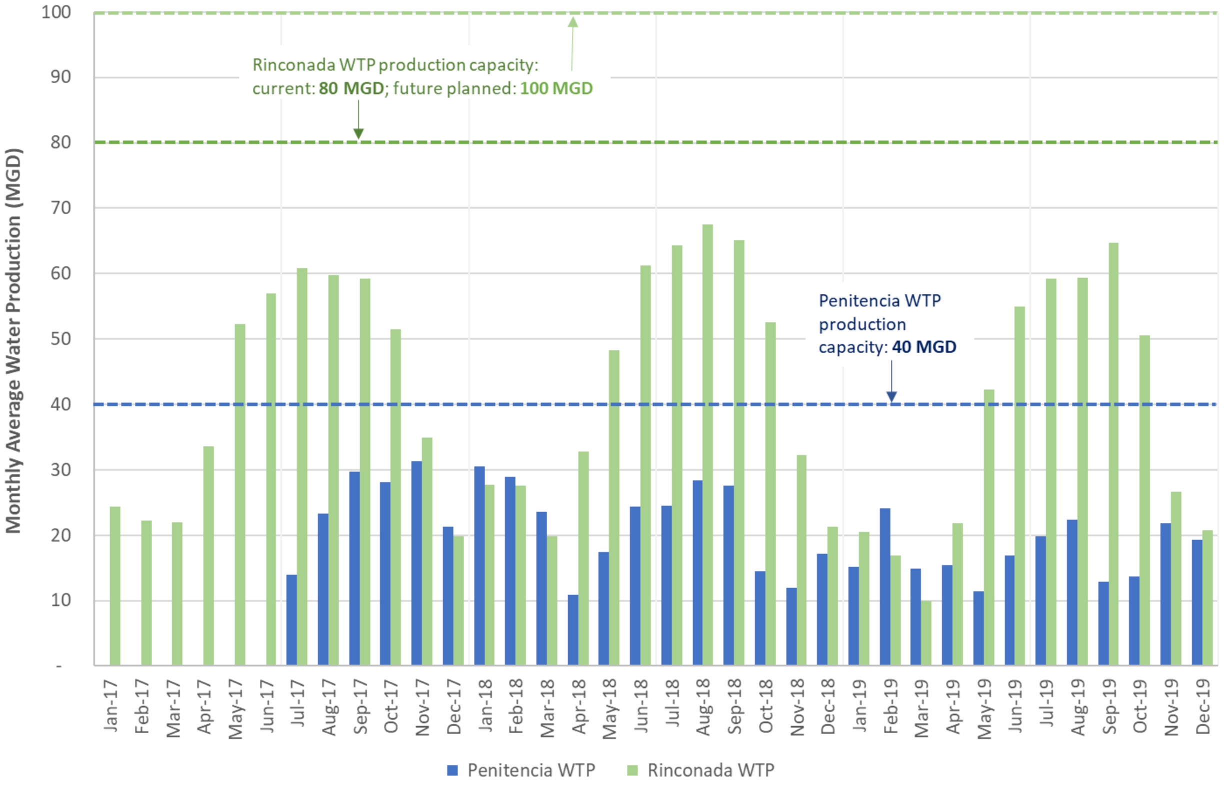


Figure 2-7. Average Monthly Production at Penitencia and Rinconada WTPs

Adding a new pipeline and pump station from LGRP to Rinconada WTP could allow purified water to flow into the upstream end of the treatment plant, creating another potential RWA scenario and increasing operational flexibility of options involving GWR. This variation would improve potable reuse supply yield when the groundwater basin is at capacity and recharge is not possible.

2.1.2.5 Treated Water Augmentation

The TWA concepts are structured with objectives of meeting potable water demand within Santa Clara County and/or complementing re-operation of other Valley Water supplies. The first TWA option would involve taking purified water produced at the San José AWPF and delivering directly to the cities of Santa Clara (areas both north and south of Highway 101) and San José (north of Highway 101), San Jose Water, and other Valley Water users by conveying purified water through the Milpitas Pipeline. Turnouts would be located near existing storage tanks, transmission mains, or other feasible locations. The other TWA scenario would also include distribution to Santa Clara and San José (north of Highway 101) and San Jose Water, but not to users along the Milpitas Pipeline, and instead would pump the purified water to the existing Piedmont Valve Yard near the Penitencia WTP. The purified water can be blended with treated water from the Penitencia WTP before distribution. These TWA concepts are discussed further in Section 3.3.

2.1.3 Treatment Processes

Reuse treatment requirements are a function of source water quality, existing WWTP processes, intended use of product water, regulatory requirements, and local/regional requirements and setting. Table 2-4 summarizes general descriptions of the various treatment unit processes used by AWPFs, their primary treatment objectives, and key process variables for monitoring compliance and performance verification.

Table 2-4. Various Treatment Processes used by AWPFs

Treatment Process	General Description	Role in AWPF Treatment Process	Process Considerations
Membrane filtration	Membrane filtration refers to low-pressure membrane processes including MF/UF. MF and UF operate primarily by size exclusion; UF membranes have an effective pore size of about 0.01 micrometers (µm), while MF membranes' effective pore size is about 0.1 µm.	Membrane filtration removes particles larger than the membrane's effective pore size, including *Giardia* and *Cryptosporidium*, but is relatively ineffective at removing viruses, organic compounds, or salinity.	Membrane filtration is typically considered a pretreatment process that protects downstream RO performance and integrity by removing particulates that may damage the RO membranes. Pathogen log removal and membrane integrity can be verified using continuous turbidity measurements and daily pressure decay tests (PDT). Log removal credit is generally limited by the PDT resolution such that credits for 4-log removal of *Cryptosporidium* and *Giardia* can be acquired.
RO	RO involves pushing water at high pressure through a partially permeable membrane and thereby removing dissolved organic compounds and ions from the water, including most CECs.	RO is used to remove pathogens and many chemical constituents. When the integrity of the RO membrane is sound, it is understood to remove essentially all pathogens from the permeate. (Note: Unlike MF/UF membranes, RO does not have an integrity test.) While most chemical constituents are removed by RO, it is less effective at removing uncharged, polar low-molecular weight compounds, particularly several classes of disinfection byproducts (DBP) like halogenated compounds and aldehydes and ketones[a].	As discussed previously, RO creates a residual stream (concentrate) that is typically 10% to 20% of the feed stream volume and creates challenges for inland disposal. Parameters used for monitoring RO performance include conductivity and total organic carbon (TOC) (often using on-line TOC analyzers). TOC removal is often used to approximate pathogen removal but regulations limit LRV credit to 2-logs for V/G/C when monitoring using TOC. Technologies such as the Trasar™ additive may be used to demonstrate greater microbial log removal credits. The use of such markers could allow for 3-logs or more credit each for V/G/C.
Ultraviolet/ advanced oxidation process (UV/AOP)	UV/AOP uses very high-intensity UV light combined with an oxidant such as chlorine, ozone, or hydrogen peroxide to provide advanced disinfection as a final polishing step following RO. Hydrogen peroxide is used as the oxidant in this analysis. The UV doses used for UV/AOP are significantly greater than the dose required in most drinking water applications. A typical dose for UV/AOP is 800-900 millijoules per square centimeter (mJ/cm^2), but only 100 mJ/cm^2 for disinfected tertiary recycled water and around 40 mJ/cm^2 for typical drinking water applications.	UV is highly effective for disinfection, providing up to 6-log inactivation of V/G/C.	The key parameters for verifying UV/AOP system performance are UV intensity, flow rate, UV transmittance (UVT) at 254 nanometers (nm), and chemical dosing rate. RO permeate typically has a UVT between 97% and 99%.
Product water stabilization: Decarbonation/air stripping and lime addition	Decarbonation/ air stripping reduces dissolved carbon dioxide, which helps minimize the quantity of lime or caustic necessary to reach a target stable pH, specific to the water quality goals of the delivery point. The decarbonators/air strippers also help reduce water temperature to address aesthetics concerns and provide an additional mechanism of chemical control (volatilization) to complement other barriers. Lime addition increases the pH, alkalinity, and calcium concentration in the water and acts to stabilize the water and minimize corrosivity.	The RO permeate that feeds into the UV/AOP is highly corrosive and can corrode conveyance pipelines, depending on pipe material. Decarbonation is combined with lime addition to accomplish product water stabilization.	As currently configured, decarbonation/air stripping is located upstream of the AOP since it is being assumed that the UV system will be using hydrogen peroxide to be consistent with previous studies and the existing SVAWPC system. In many designs, decarbonation/air stripping is either located downstream of UV/AOP or not included, depending on unconditioned treated water quality and final water quality goals. Relocation of decarbonation/air stripping downstream of the UV/AOP to allow for flexibility in UV/AOP oxidant selection and optimize water stabilization is recommended for consideration. Only a portion of the product water will be decarbonated/air stripped and then blended with remaining product water. The amount of lime needed, as well as the entire post-treatment strategy, is determined using various corrosivity indices, such as the Langelier Saturation Index or Aggressiveness Index, and would be informed by corrosion control studies. Sodium hypochlorite would also be added to the product water to help neutralize the remaining hydrogen peroxide from the AOP and provide free chlorine residual to prevent microbial growth in the conveyance pipeline.
Chlorine disinfection	Chlorine disinfection provides additional protection against microbes and viruses, as well as a residual for distribution. It is used to provide additional LRV credits for RWA and TWA. Dose and contact time may be based on EPA guidance for disinfection of drinking water.	Both RWA and TWA do not benefit from LRV credits that GWR gains from retention in a groundwater aquifer, and free chlorine disinfection can achieve additional LRV credits for viruses and *Giardia*. It is ineffective for *Cryptosporidium*. Chlorine can also provide residual disinfectant to prevent biofilm growth in the distribution system.	For TWA, purified water would be routed through chlorine contact basins that would provide sufficient detention time for disinfection to occur; additionally, an 8-hour clearwell provides emergency storage in the event of process interruptions. Free chorine disinfection would be implemented in the pipeline between the AWPF and Penitencia WTP for both RWA and TWA.
O_3- BAC	The O_3 process is a chemical oxidation and disinfection process that (1) oxidizes organic matter for ready biodegradation by microorganisms in the BAC and (2) provides targeted LRV credits required for the project. BAC is a biological process that metabolizes the organic matter in the O_3 effluent to increase the removal of bulk organics (TOC) and further reduces the concentration of CECs.	In the proposed RWA treatment train, O_3 and BAC is a combined pre-treatment process that removes organic matter and CECs, including trace organics such as N-nitrosodimethylamine (NDMA). The O_3-BAC process helps address two of the priority topics for DPR in California—control of chemical peaks and low-molecular weight compounds, e.g., certain DBPs. O_3-BAC treatment is also expected to reduce CECs in ROC.	BAC is typically designed with granular activated carbon (GAC) media because GAC has a larger surface area to attract microorganisms to the particle surfaces. BAC does not provide pathogen reduction or reduce salinity. A contact vessel provides the necessary residence time for reaction, and O_3 residuals are monitored at multiple points along the contactor vessel. Each residual monitoring point can be used for performance verification. Performance can also be monitored via TOC analyzers on the filtrate.

a. *Marron, et al. (2019)*

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2.1.3.1 NPR and NPR+

The four WWTPs in the County include recycled water production facilities that meet Title 22 disinfected tertiary recycled water requirements. At the SJ/SC RWF, Valley Water's SVAWPC also provides purified water to reduce salinity of SBWR's NPR supply. A similar facility is planned at the Palo Alto RWQCP and will include MF/UF and RO facilities as identified in the City of Palo Alto's 2017 *Advanced Water Purification System Feasibility Study - Final*. Figure 2-8 shows the process flow diagram for the proposed Palo Alto facility.

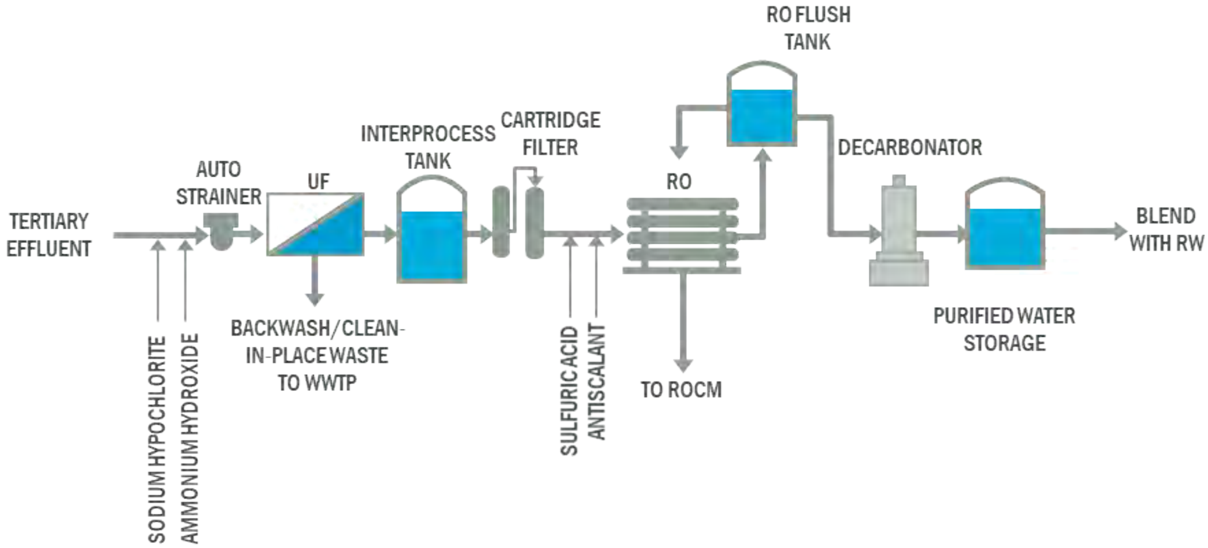

Figure 2-8. Palo Alto NPR+ process flow diagram

Source: Palo Alto, Mountain View, and Valley Water (2017)

If NPR systems in North County were connected through interties, Sunnyvale may also consider an AWPF to provide water quality consistent with SBWR and PA/MV systems. This facility would include MF/UF, RO, disinfection, and associated ancillary facilities to support production of NPR+.

For the SBWR service area, NPR+ distribution system expansion is planned, and new requests for recycled water will increase demand on the system. To continue serving blended water quality with salinity under 500 mg/L during peak months, the existing SVAWPC may need to be expanded or a new facility would need to be constructed. If water quality can vary over the course of the year with an average salinity of 500 mg/L, then a smaller capacity increase would be needed, if any at all. Figure 2-9 shows the process flow diagram for the proposed San José facility that would match the existing SVAWPC and expand NPR+ supply.

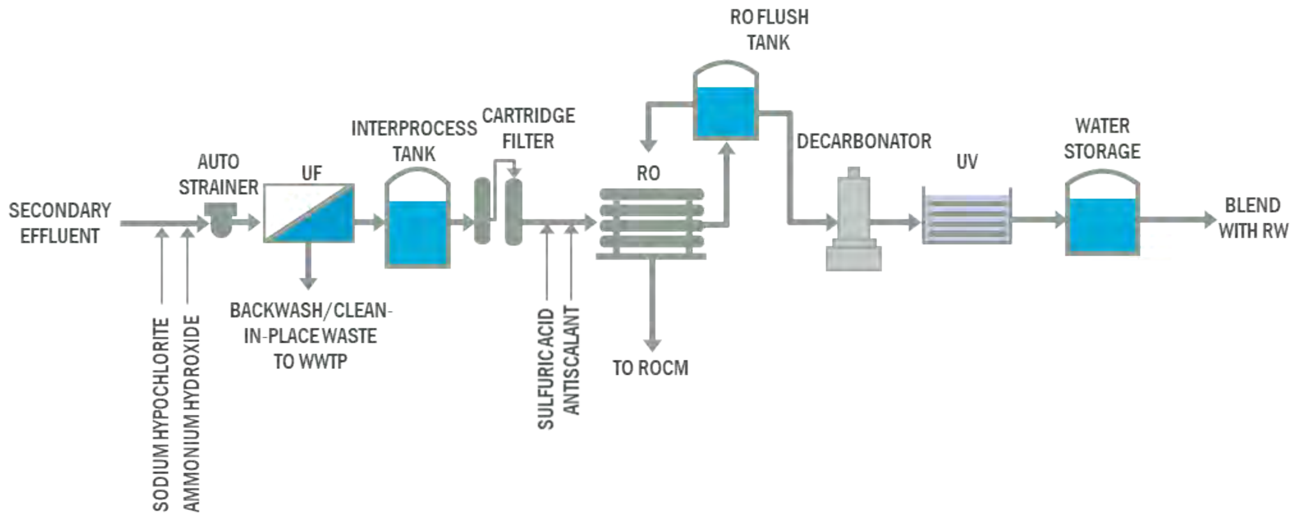

Figure 2-9. NPR+ process flow diagram for San José AWPF (based on SVAWPC)

Table 2-5 summarizes the estimated costs for NPR+ facilities.

Table 2-5. Estimated Costs for NPR+ AWPF

Element	Palo Alto NPR+[b] ($2019, in millions)	Sunnyvale NPR+[c] ($2019, in millions)	SBWR NPR+[d] ($2019, in millions)
Total Capital Cost	$21	$18	$83
O&M Costs	$1.0	$0.5	$2.8
Projected NPR Demand (2040)[a]	2.5 mgd	1.5 mgd	27.6 mgd

a. *Palo Alto and Sunnyvale NPR demand projections from 2015 UWMP; SBWR retailers' projections updated based on input from SBWR staff.*

b. *Based on estimated cost for 2.25-mgd facility in Advanced Water Purification System Preliminary/Conceptual Design Report, December 2017. Estimated cost escalated to August 2019 value, as described in Appendix A-5.*

c. *The estimated cost for the Sunnyvale 1.2-mgd facility was scaled from the Palo Alto Facilities estimated cost.*

d. *The estimated cost for an additional 8-mgd facility SJ/SC NPR+ facility was based on the existing SVAWPC construction cost and escalated to August 2019 value. Implementation cost factors, as provided in Appendix A-5 - Basis of Cost, were applied to the estimated construction cost to develop a total capital cost.*

2.1.3.2 Groundwater Recharge

Though FAT provides a higher level of treatment than the minimum required by regulations for GWR via surface spreading, Valley Water selected FAT as the preferred treatment train for GWR to protect groundwater quality, limit salt and nutrient loading, and guard against potential impacts from emerging contaminants such as per- and polyfluoroalkyl substances (PFAS). A FAT process train composed of membrane filtration, RO treatment, and UV/AOP also allows for GWR via injection wells—an option previously identified in the Expedited Purified Water Program Plan. Furthermore, FAT can reduce TOC concentrations to levels that allow GWR without a need for dilution water.

Treatment goals and default pathogen reduction credits granted for each FAT unit process are summarized in Table 2-6. LRV requirements (12/10/10 log reduction of V/G/C) are dictated by Title 22, Article 5.1 (IPR: Groundwater Replenishment, Surface Application). California's approach assumes log removal credits are met starting from untreated wastewater. State regulations only allow up to 6-log removal of any pathogen per unit process, excluding underground retention. A FAT process train demonstrates at least 1-log removal of each pathogen with three different barriers.

Table 2-6. GWR FAT-Based Advanced Treatment Performance

Unit processes	Microbiological log removal credits			Organic matter removal		Salinity
	Viruses	*Giardia*	*Cryptosporidium*	Dissolved TOC	CECs[a]	
Default credits						
Secondary Effluent	0.4	0.2	0	Yes	Yes	No
UF	0	4	4	No	No	No
RO	1.5	1.5	1.5	Yes	Yes	Yes
UV/AOP	6	6	6	No	Yes	No
Underground retention / soil aquifer treatment	6[b]	10[c]	10[c]	Yes	Yes	No
Total	13.9	21.7	21.5	--	--	--
Required credits						
Required	12	10	10	Yes	Yes[d]	No[e]
Balance	1.9	11.7	11.5	--	--	--

a. *Each unit process targets certain CECs, but not all CECs will be removed.*

b. *A 1-log credit is granted for each month of underground retention time demonstrated with an added tracer. This credit drops to 0.5-log per month when underground retention time is demonstrated with a numerical model. For subsurface application, for each month retained underground, recharge water credited with 1-log virus reduction per CCR, Title 22, Division 4, Chapter 3, Article 5.2, Section 60320.208 (groundwater replenishment–subsurface application). Groundwater modeling results show purified water introduced at LGRP is retained for at least one year before reaching potable supply wells.*

c. *A 10-log credit is granted for Giardia and Cryptosporidium for surface spreading when 6 months underground retention time is demonstrated with a tracer study. This credit drops to 0-logs if the AWPF is used for injection.*

d. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk and are informed by site-specific water quality monitoring and current and proposed regulations. Typical removal rates range from 70% to more than 99%, depending on the unit processes.*

e. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

Potential GWR project elements in North County involve source water from Palo Alto RWQCP, Sunnyvale WPCP, and/or SJ/SC RWF for purified water production and conveyance to LGRP. The South County GWR option would involve diverting Morgan Hill’s liquid stream to a satellite facility for treatment, along with an AWPF. Estimated AWPF costs assumed an online factor of 90% to account for equipment downtime for maintenance and improvements. The factor increases the overall production capacity of the AWPF with the intent of reaching the production target of 24,000 AFY.

While facility layouts and designs are often driven by agency perspectives and culture, the existing SVAWPC was used to inform the proposed AWPF layouts. Key aspects of the existing SVAWPC include locating major equipment for the UF, RO, and UV/AOP systems within a process building to provide protection from the weather. For site planning, representative equipment layouts were arranged within the building to allow for efficient O&M access. The process building also includes space for staff and facilities to support operation and maintenance of the AWPF. Ancillary facilities, chemical storage, water storage, and pumping facilities are assumed to be outside or under canopies.

North County AWPFs used for GWR share a similar process flow diagram (Figure 2-10).

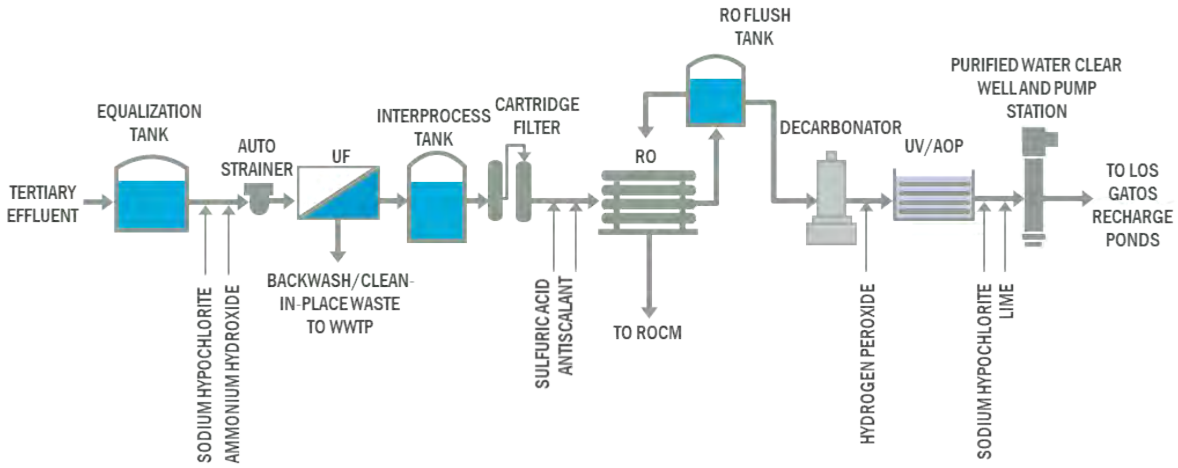

Figure 2-10. AWPF process flow diagram for GWR

The Morgan Hill satellite facility would require wastewater treatment facilities in addition to AWPF facilities to meet regulatory requirements. The envisioned treatment process is to use an MBR process followed by RO and UV/AOP (Figure 2-11). MBR was selected as the treatment choice for Morgan Hill because a facility for treating wastewater to secondary effluent quality does not currently exist. An MBR can be used to provide both biological nutrient removal, organic matter removal, and particulate filtration for the subsequent RO process at a lower cost than individual activated sludge and membrane filtration. In addition, MBR is an effective process for sites with relatively small footprints and limited flow variation, like Morgan Hill. MBR has not yet been granted LRV credit in California, but several projects are planning on using the Australian Tier 1 approach for LRV credit, and the Tier 1 LRV values are assumed in these concepts for planning purposes.

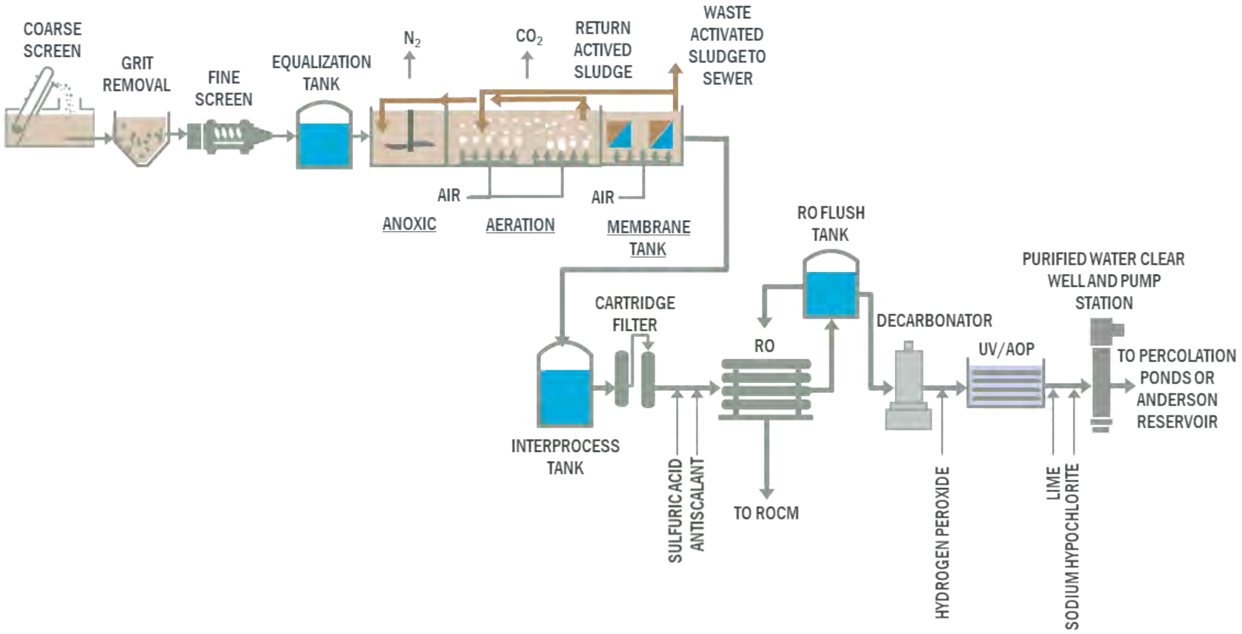

Figure 2-11. Morgan Hill satellite treatment facility process flow diagram

To meet the California regulations of 12/10/10 for V/G/C, advanced monitoring equipment for RO, such as dye monitoring or TRASAR technology, would be added to confirm LRV performance and credit. Furthermore, disinfection with free chlorine could be added to achieve additional credits for virus and *Giardia*. Table 2-7 summarizes the LRVs for each process to meet GWR requirements. As MBR does not provide significant removal of CECs, salinity, and dissolved organic carbon, only LRV credits are summarized in Table 2-7.

Table 2-7. Log Removal Credits for Morgan Hill Satellite Facility and AWPF

Unit process	Log removal credits		
	Virus	*Giardia*	*Cryptosporidium*
MBR[a]	1.5	2	2
RO[b]	3	3	3
UV/AOP	6	6	6
Underground retention[c]	2	0	0
Total	12.5[d]	11[d]	11

a. MBR LRV credits based on the Australian Tier 1 approach.

b. RO process assumes advanced monitoring would support LRV credit of 3-3-3 for V/G/C.

c. Virus removal of 1-log is granted for each month of travel time in the groundwater basin.

d. Free chlorine disinfection can be added to increase LRV credits for virus and Giardia.

For the SWA approach using Anderson Reservoir as a delivery point from the Morgan Hill satellite facility, at least one additional process would be needed to meet required log removal for viruses, as there is no credit for underground retention as in GWR. Free chlorine disinfection could be implemented, which can provide up to 6 LRVs for virus with a CT of 2 mg/L-min (Pecson et. al, 2017), as well as ozone-biologically active carbon.

2.1.3.3 Raw Water Augmentation

The Expedited Purified Water Program Plan evaluated a potential RWA project that would blend purified water and SBA raw water to supply the Penitencia and Rinconada WTPs. Based on DDW's current position on DPR, a treatment train to meet anticipated regulatory requirements is likely to require FAT as a minimum baseline level of treatment, and additional treatment elements will likely be needed to comply with stricter requirements for both pathogen and chemical control. A FAT process train with the addition of O_3-BAC pretreatment and free chlorine disinfection would likely be capable of satisfying the minimum requirement for RWA facilities.

While DDW has not yet established pathogen requirements for RWA, an initial assessment of processes for the RWA treatment train were selected considering both pathogen and chemical treatment. (Refer to Table 2-4 for a general description of each unit process, its role in the RWA AWPF train, and key process variables for monitoring performance.) Table 2-8 provides default credits and demonstrates the level of pathogen treatment applicable to each treatment process. Virus and *Giardia* are expected to have high LRV, exceeding IPR requirements and likely in compliance with future RWA regulations. *Cryptosporidium* LRV also exceeds the IPR requirements. LRV redundancy will be beneficial for operating AWPFs and maintaining a high degree of system availability (i.e., online reliability). This benefit supports the strategy of seeking additional credits, which may be most cost-effectively accomplished by seeking higher credits for existing processes. Some processes may be credited with higher LRV (e.g., through treatment studies or different monitoring approach) within the future RWA regulations.

Table 2-8. RWA FAT-Based Advanced Treatment Performance

	Microbiological log removal credits			Organic matter removal				
Unit Processes	Viruses	*Giardia*	*Crypto-sporidium*	Dissolved TOC	CECs[a]	Chemical peaks	Low-molecular-weight compounds	Salinity[b]
Default credits								
Tertiary effluent SJ/SC RWF	0.4[c]	0.2[c]	0[c]	Yes	Yes	--	--	No
O_3/BAC	6	6	1	Yes	Yes	Yes	Some	--
UF	0	4	4	No	No	No	No	No
RO	2	2	2	Yes	Yes	Yes	Some[d]	Yes
UV/AOP	6	6	6	No	Yes[e]	Yes[e]	Some[e]	No
Air stripping	0	0	0	No	No	Some[h]	No	No
Free chlorine disinfection	6	1	0	No	No	No	No	No
RWF and AWPF total	20.4	19.2	13	--	--	--	--	--
WTP credits[f]	4	3	2	No	No	No	No	No
Total	24.4	22.2	15	--	--	--	--	--
Required credits								
Required	TBD	TBD	TBD	Yes	Yes[g]	Yes	Yes	No[b]

a. *Each unit process targets certain CECs, but not all CECs will be removed.*

b. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

c. *Default credit expected for secondary treatment extrapolated from Rose (2004) study*

d. *RO is typically less effective for control of low molecular-weight organic compounds that are uncharged and polar (e.g., acetone). Rodriguez, C et al. (2009)*

e. *UV/AOP will provide some treatment for chemical peaks of constituents amenable to treatment by the process (e.g., 1,4-dioxane)*

f. *Current regulations for SWA allow for some pathogen removal credits from the surface WTPs. It is assumed that RWA could be granted the same credits; however, the current understanding of the future RWA regulations suggest that the credits will have to be demonstrated with monitoring, similar to crediting for PR facilities.*

g. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk and are informed by site-specific water quality monitoring and current and proposed regulations. Typical removal rates range from 70% to more than 99%, depending on the unit processes.*

h. *Air stripping, which can be accomplished with air strippers or decarbonators, provides another barrier for chemical control, such as removal of volatile organic compounds*

Treatment will only be one of the requirements for RWA. Compared to IPR, DPR requirements will be more stringent for source control, wastewater treatment, response time, monitoring, and failure response (i.e., diversions, alternate supply, operator training). The Master Plan will provide more detail on these topics.

The proposed 24-mgd RWA AWPF would be constructed adjacent to the existing SVAWPC and treat tertiary effluent from the SJ/SC RWF to produce purified water. The AWPF would be located on the approximate 17.8-acre parcel immediately adjacent to the existing SVAWPC. Figure 2-12 depicts the process flow diagram for this facility.

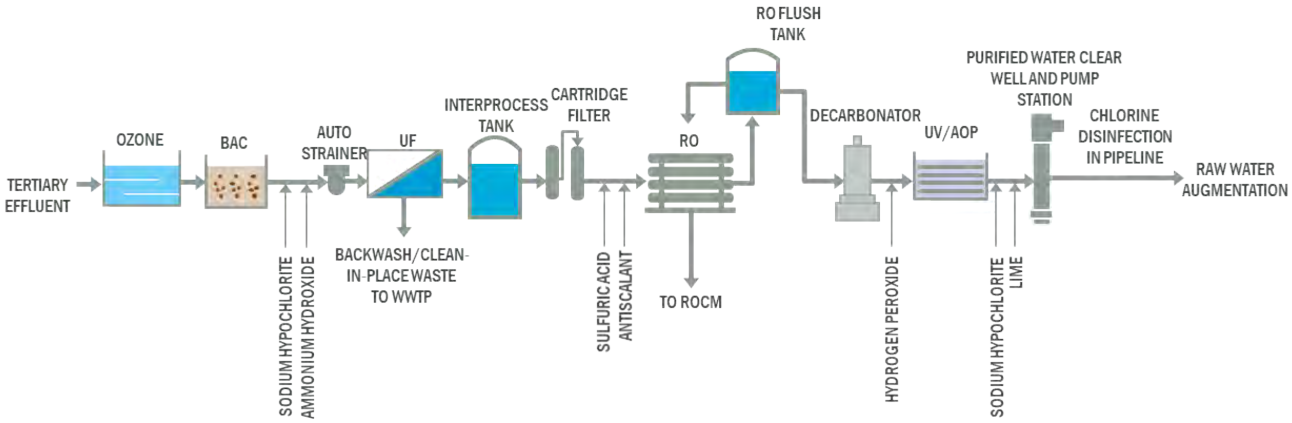

Figure 2-12. AWPF process flow diagram for RWA

Beyond the preliminary design criteria summarized in Appendix A-3 for the 24-mgd AWPF for RWA, the Expedited Purified Water Program DPR Facilities Plan provides a more in-depth description of design details.

2.1.3.4 Treated Water Augmentation

As mentioned previously, the DDW released a proposed framework for regulating DPR in 2018 and a second edition of the framework in August 2019. The framework provides a common structure to help assess and manage risks associated with DPR, identifies key factors and approaches to protect public health across various forms of DPR (i.e., TWA and RWA), and establishes a timeline to develop DPR regulations by December 31, 2023, with provisions for extending the deadline. While the initial framework focused on a phased approach to developing DPR regulations starting with RWA regulations, DDW revised the approach and, as reflected in the second edition, anticipates developing a single DPR regulation package inclusive of both RWA and TWA by December 2023. The potential for TWA regulations to be established by December 2023 represents a changed condition for developing potable reuse opportunities in the Master Plan and allows for TWA opportunities to be considered in this effort.

In the absence of established regulations, TWA concepts were developed based on assumptions that draw on existing potable reuse regulations, the second edition framework, and current industry best practices. Based on DDW's current position on DPR, FAT is anticipated to be the minimum baseline, and additional treatment elements will likely be needed to comply with stricter requirements for pathogen and chemical control. A FAT process train with the addition of O_3-BAC pretreatment and chlorine disinfection was assumed to be the minimum requirement for TWA facilities.

With ample pathogen reduction in the treatment processes for RWA, the TWA treatment train focuses on additional chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time. While secondary treated effluent is currently successfully treated at SVAWPC, Valley Water proposes to require tertiary level of treatment for effluent in TWA projects as an added safeguard to further protect public health and to improve AWPF treatment effectiveness/ redundancy. In lieu of additional log reduction value LRV requirements, this treatment train considers the potential to demonstrate higher LRVs for the upstream WWTP(s) or RO (Table 2-9), if needed.

Table 2-9. TWA FAT-Based Advanced Treatment Performance

Unit processes	Microbiological log removal credits	Control of chemical compounds	Salinity[b]

	Viruses	*Giardia*	*Crypto-sporidium*	TOC	CECs[a]	Chemical peaks	Low molecular-weight compounds	
Default credits								
Tertiary WW treatment	0.5[c]	0.5[c]	0.5[c]	Yes	Yes	--	--	No
Ozone/BAC	6	6	1	Yes	Yes	Yes	Yes	No
UF	0	4	4	No	No	No	No	No
RO	2.5[d]	2.5[d]	2.5[d]	Yes	Yes	Yes	Some[e]	Yes
UV/AOP	6	6	6	No	Yes[f]	Yes[f]	Yes[f]	No
Cooling tower/air stripper	--	--	--	No	Yes	Yes	Yes	No
Chlorine disinfection	6	1	0	No	No	No	No	No
Total	21	20	14	--	--	--	--	--
Required credits								
Required	TBD	TBD	TBD	Yes	Yes[a]	Yes	Yes	No[b]

a. *Not all CECs require specific removal rates. The requirements can vary based on known or perceived human health risk. Typical removal rates range from >70% to over 99%.*

b. *Managing salinity is a long-term sustainability issue that must be considered in the treatment process selection. Not every system will require salinity removal.*

c. *Conservative estimate for pathogen LRVs stemming from site-specific pathogen monitoring study.*

d. *Assumes facility uses enhanced RO monitoring (such as TRASAR) for additional RO crediting.*

e. *RO is typically less effective for control of low molecular weight organic compounds that are uncharged and polar.*

f. *UV/AOP will provide some treatment for chemical peaks of constituents amenable to treatment by the process (e.g. 1,4-dioxane).*

The proposed 24-mgd TWA AWPF would be constructed adjacent to the existing SVAWPC and treat tertiary effluent from the SJ/SC RWF to produce purified water. Treatment processes were selected considering both pathogen and chemical treatment in terms of microbiological log removal, control of chemical compounds, and salinity reduction and structured as a proposed TWA treatment train (Figure 2-13). Future DPR regulations are assumed to include additional requirements to address two topics of concern for chemical control: (a) attenuation of chemical peaks (i.e., high concentrations of chemicals that may be released into the treatment process, as from an industrial spill), including both known and unknown compounds; and (b) increased removal of low molecular weight compounds, including both known and unknown compounds that have been observed to pass through FAT trains. The selected TWA treatment train is believed adequate to address these two DPR chemical control issues. Both the potential future regulatory requirements and justification for the proposed TWA treatment train are described in the Master Plan (including Appendix B).

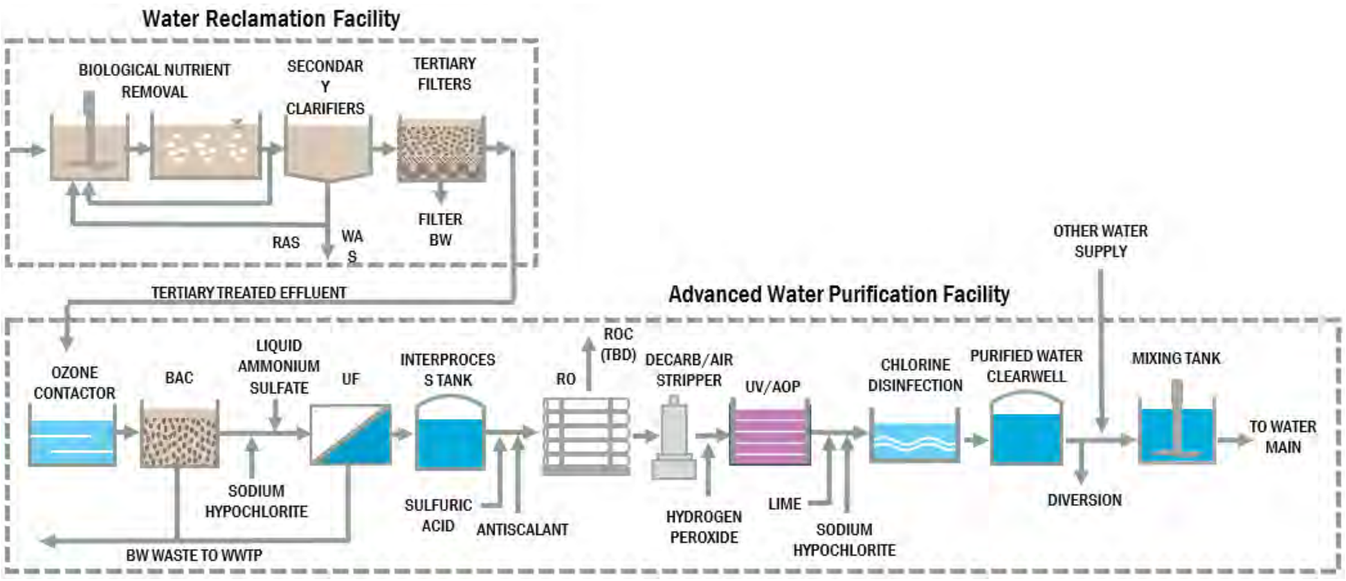

Figure 2-13. AWPF process flow diagram for TWA

2.2 Residuals Management

Each potential AWPF is anticipated to consist of a process train that includes RO membrane filtration and UV/AOP. MF/UF pretreatment is anticipated for AWPFs in North County, and backwash water from the MF/UF treatment is expected to be returned to the head of the respective WWTP. In South County options, MBR residuals from the Morgan Hill satellite facility may be discharged to SCRWA, although this would require further study and a future agreement. Issues related to residuals management in South County are discussed in Section 3.5.

ROC management strategies will vary depending on AWPF location and capacity. Various management options are being considered as part of Valley Water's ROCMP developed in parallel with the Master Plan and included in Appendix G. The ROCMP team is informing the feasible portfolios evaluation, specifically in terms of site-specific ROC management options, costs, and permitting complexity.

Table 2-10 presents the primary ROC management strategy recommended for each proposed AWPF, as reflected in Valley Water's most recently available ROCMP TMs (Appendix G). For locations where more than one ROC management strategy is identified, Option 1 is reflected in AWPF capital costs in Sections 3 and 4 of this TM.

Table 2-10. ROC Management Recommendations from ROCMP team			
AWPF location	**Option 1 description**	**Option 2 description**	**Option 3 description**
San José Regional AWPF	Blend ROC with residual final effluent downstream of the compliance point for the SJ/SC RWF (i.e., after the weir).	Discharge ROC to a new shallow outfall at a point in Coyote Creek that has been shown by hydrodynamic modeling to provide enhanced mixing.	n/a
Combined Regional AWPF in Palo Alto	Blend and discharge ROC to the existing outfall from the Palo Alto RWQCP.	Discharge ROC to a new outfall at a point in SF Bay that has been shown to provide enhanced mixing.	Discharge the ROC to an existing deep-water outfall located in Redwood City and discharges past the Dumbarton Bridge.
Combined Regional AWPF in Sunnyvale	Discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	n/a	n/a
Separate AWPFs in Palo Alto and Sunnyvale	At Palo Alto, blend and discharge ROC to the existing outfall from the Palo Alto RWQCP. At Sunnyvale, discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	At Palo Alto, discharge ROC to a new outfall at a point in SF Bay that has been shown to provide enhanced mixing. At Sunnyvale, discharge ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.	At Palo Alto, discharge the ROC to a deep-water outfall north of the Dumbarton Bridge. At Sunnyvale, discharge the ROC to a new shallow outfall at a point in Guadalupe Slough that has been shown to provide enhanced mixing.
AWPF in Morgan Hill	Morgan Hill AWPF ROC would be piped to an evaporation pond located on SCRWA property in Gilroy.	n/a	n/a

Other management options were considered but determined to be infeasible based on the ROCMP team's evaluation. For example, deep well injection is infeasible based on Valley Water's policy for aggressively protecting the groundwater basin. In addition, full-scale implementation of treatment was eliminated after a pilot study did not show effective removal of chelated metals or selenium from ROC. Treatment for nutrients, chronic toxicity, and CECs may be possible but requires further study.

The ROCMP team selected management options based on an assessment of water quality impacts to the SF Bay and an individual facility's ability to meet NPDES permit requirements. The ROCMP team conducted mass balance dilution modeling to evaluate water quality impacts of ROC discharge at the various outfall locations. Presented in the following subsections are recommended ROC management options for each AWPF with descriptions of NPDES permitting issues, contaminants that affect each location, and costs associated with the ROC management options. Figure 2-14 shows the locations of pipelines proposed by the ROCMP team for recommended ROC management strategies.

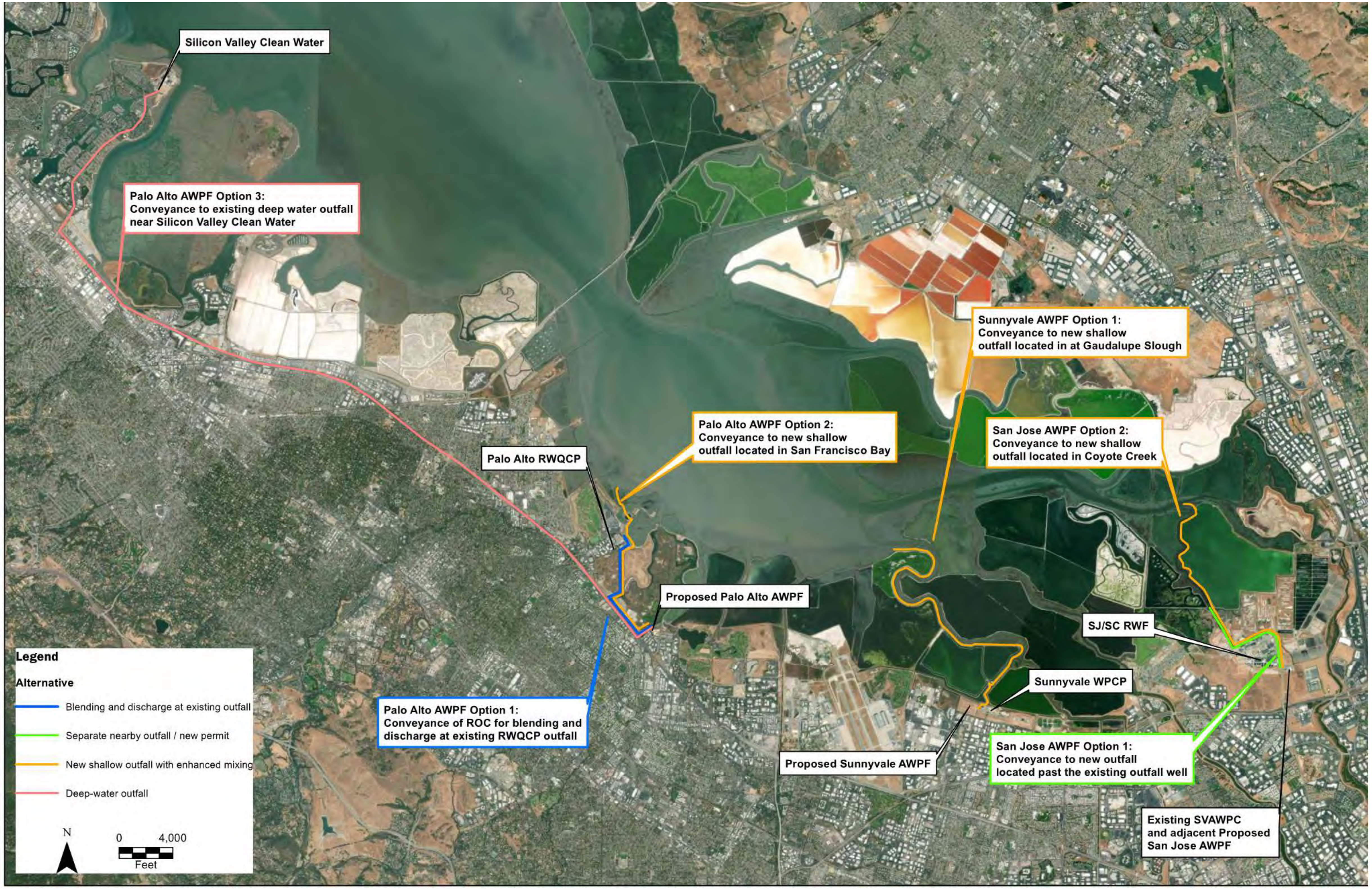
Silicon Valley Clean Water
Palo Alto AWPF Option 3:
Conveyance to existing deep water outfall near Silicon Valley Clean Water
Sunnyvale AWPF Option 1:
Conveyance to new shallow outfall located in at Gaudalupe Slough
Palo Alto AWPF Option 2:
Conveyance to new shallow outfall located in San Francisco Bay
San Jose AWPF Option 2:
Conveyance to new shallow outfall located in Coyote Creek
Palo Alto RWQCP
Proposed Palo Alto AWPF
SJ/SC RWF
Sunnyvale WPCP
Legend
Alternative
Blending and discharge at existing outfall
Separate nearby outfall / new permit
New shallow outfall with enhanced mixing
Deep-water outfall
Palo Alto AWPF Option 1:
Conveyance of ROC for blending and discharge at existing RWQCP outfall
Proposed Sunnyvale AWPF
San Jose AWPF Option 1:
Conveyance to new outfall located past the existing outfall well
Existing SVAWPC and adjacent Proposed San Jose AWPF
N
0 4,000
Feet

Figure 2-14. ROC management strategies, North County (as identified by the ROCMP Team)

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2.2.1 ROC Management for San José AWPF (24 mgd)

The 24-mgd San José AWPF would be located adjacent to the existing 8-mgd SVAWPC. The new AWPF would produce up to 4.2 mgd of ROC. Currently, a portion of SJ/SC RWF's tertiary-treated effluent is recycled by tertiary treatment and distributed via SBWR. Secondary effluent flow feeds SVAWPC for purification for NPR+. The remaining flow is discharged to the SF Bay via an outfall at the Artesian Slough, as regulated under an existing NPDES permit.

The components assumed by the ROCMP team to be required to manage ROC at a San José AWPF for each of the two ROC management options are presented in Table 2-11.

Table 2-11. ROC management strategies for Portfolio 1, San José AWPF (24 mgd)

ROC management option	Components of ROC management option
Option 1: Blending and discharge at new outfall downstream of existing outfall discharge weir	• 9,600 ft, 18” high-density polyethylene (HDPE) pipe (from AWPF to new outfall) • ROC pump station and holding tank • Outfall diffuser • Optional treatment processes for nutrients and CECs
Option 2: Discharge at a new shallow outfall at Coyote Creek	• 20,000 ft, 18” HDPE pipe (from AWPF to new outfall) • ROC pump station and holding tank • Outfall diffuser • Optional treatment processes for nutrients and CECs

2.2.2 ROC Management for Combined Regional AWPF in Palo Alto (24.5 mgd)

Final effluent feed from the Palo Alto RWQCP and the Sunnyvale WPCP, conveyed to Palo Alto via a new pipeline, would feed the 24.5-mgd Combined Regional AWPF in Palo Alto, generating roughly 4.3 mgd of ROC.

Most of the final effluent from the Palo Alto RWQCP is currently discharged to the SF Bay. A small portion is discharged to Matadero Creek, and the remainder is distributed as Title 22-compliant tertiary-treated recycled water. The City of Palo Alto is currently proceeding with a 2.25-mgd AWPF that will blend permeate with tertiary-treated recycled water at a 1:1 ratio to provide NPR+. The AWPF will reduce TDS levels in recycled water from the current range of 770 mg/L-1,100 mg/L down to a target range of 400 mg/L – 500 mg/L as described in the 2017 Advanced Water Purification System Feasibility Study – Final. The existing Palo Alto RWQCP NPDES permit includes a dilution credit of 3.5:1 for copper and a dilution credit of 3.25:1 for cyanide.

The components assumed by the ROCMP team to be required to manage ROC from a Combined Regional AWPF in Palo Alto for each of the three ROC management options are presented in Table 2-12.

Table 2-12. ROC Management Strategies for Portfolio 2a, Combined Regional AWPF in Palo Alto (24.5 mgd)

ROC management option	Components of ROC management option
Option 1: Blending and discharge at existing RWQCP outfall	• 10,900 ft; 18" HDPE pipe (from AWPF to existing outfall) • ROC pump station and holding tank
Option 2: Discharge at a new shallow outfall in San Francisco Bay	• 14,600 ft; 18" HDPR pipe from AWPF to existing outfall • 5,000 ft 18" HDPE pipe to location under SF Bay • ROC pump station and holding tank
Option 3: Deep water outfall north of Dumbarton Bridge	• 70,300 ft; 20" HDPE pipe (from AWPF to existing deep-water outfall in Redwood City) • ROC pump station and holding tank

2.2.3 ROC Management for Combined Regional AWPF in Sunnyvale (24.5 mgd)

Final effluent feed from the Sunnyvale WPCP and the Palo Alto RWQCP, piped to the AWPF via a new pipeline, would feed the 24.5-mgd Combined Regional AWPF at Sunnyvale, generating roughly 4.4 mgd of ROC. Final effluent from the Sunnyvale WPCP is currently discharged to the South Bay via Moffett Channel.

The components assumed by the ROCMP team to be required to manage ROC from a Combined Regional AWPF in Sunnyvale are presented in Table 2-13.

Table 2-13. ROC management strategies for Portfolio 2b, Combined Regional AWPF in Sunnyvale (24.5 mgd)

ROC management option	Components of ROC management option
Option 1: New shallow outfall at Guadalupe Slough	• 32,800 ft; 18" HDPE pipe (from AWPF to new outfall location) • ROC pump station and holding tank • Outfall diffuser

2.2.4 ROC Management for Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd)

Separate regional AWPFs with 14.0 mgd and 10.5 mgd production capacities at Palo Alto and Sunnyvale, respectively, would yield maximum ROC flows of 2.5 mgd and 1.9 mgd (Palo Alto and Sunnyvale, respectively). In this case, the WWTPs would not blend their separate streams of treated effluent. Modeling indicates that ROC discharge at Palo Alto for its separate AWPF maintains compliance with existing NPDES permits while discharge from the Sunnyvale AWPF requires a permit negotiation for dilution credits.

The components assumed by the ROCMP team to be required for managing ROC at separate Palo Alto / Sunnyvale AWPFs are presented in Table 2-14.

Table 2-14. ROC Management Strategies for Portfolio 4, Separate AWPFs in Palo Alto (14 mgd) and Sunnyvale (10.5 mgd)	
ROC management option	**Components of ROC management option**
Option 1 Palo Alto: Blending and discharge at existing RWQCP outfall Sunnyvale: New shallow outfall at Guadalupe Slough	• 10,900 ft; 14" HDPE pipe (from Palo Alto AWPF to existing outfall) • ROC pump station and holding tank at Palo Alto • 32,800 ft; 12" HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale
Option 2 Palo Alto: Discharge at a new shallow outfall in SF Bay Sunnyvale: New shallow outfall at Guadalupe Slough	• 14,600 ft; 14" HDPE pipe from Palo Alto AWPF to beyond existing outfall • 1,000 ft, 18" HDPE pipe under SF Bay to new outfall • ROC pump station and holding tank at Palo Alto • 32,800 ft; 12" HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale
Option 3 Palo Alto: Convey ROC to existing deep water outfall in Redwood City (at Silicon Valley Clean Water) Sunnyvale: New shallow outfall at Guadalupe Slough	• 70,300 ft; 14" HDPE pipe (from Palo Alto AWPF to existing deep water outfall in Redwood City at Silicon Valley Clean Water) • ROC pump station and holding tank at Palo Alto • 32,800 ft; 12" HDPE pipe (from Sunnyvale AWPF to new outfall) • ROC pump station and holding tank at Sunnyvale • Outfall diffuser at Sunnyvale

2.2.5 ROC Management for Morgan Hill AWPF (2 mgd)

The inland location of the Morgan Hill AWPF limits ROC management options. The ROCMP team recommended a single option: convey ROC to a lined evaporation pond near the SCRWA facility in Gilroy.

The components assumed by the ROCMP team to be required to manage ROC from a Morgan Hill AWPF are presented in Table 2-15.

Table 2-15. ROC Management Strategies for Morgan Hill AWPF (2 mgd) Evaporation Pond in Gilroy	
ROC Management Option	**Components of ROC Management Option**
Option 1: Conveyance to a lined evaporation pond in or near Gilroy	• 58,600 ft, 8" HDPE pipe (from AWPF to SCRWA area) • ROC pump station and holding tank • 83-acre pond – land purchase/lease and excavation

2.3 Conveyance/Distribution

Conveyance and distribution project elements include:

- NPR/NPR+ distribution system expansions
- Interties between recycled water distribution systems
- Effluent pipelines from WWTPs to AWPFs for treatment
- Purified water pipelines from AWPFs to delivery points
- LGRP piping improvements
- Penitencia WTP improvements
- ROC Management pipelines
- Pump stations

2.3.1 NPR/NPR+ Distribution Systems

NPR programs are established at each of the WWTPs in the County, and expansion of NPR use is envisioned to be a key water supply for water retailers in the future. A market assessment was presented in Attachment A of Appendix F, Conceptual Alternatives TM, including known potential NPR/NPR+ projects in the County sorted by retailer and distribution system. Since development of the Conceptual Alternatives TM, information has been updated to include additional projects studied by Valley Water and Palo Alto within their service area, as well as indications for how additional recycled water may be used within the SBWR service area through the 2040 planning horizon.

Potential future NPR/NPR+ projects are described below and summarized in Table 2-15.

Palo Alto and East Palo Alto NPR+. On March 2, 2020, Palo Alto's City Council accepted the Final Northwest County Recycled Water Strategic Plan. This report presented three NPR+ concepts within Palo Alto and Los Altos, one in East Palo Alto, and two in Mountain View. The report indicated that Stanford University did not foresee a need for recycled water from the Palo Alto RWQCP due to its use of its lake water system.

Though no specific alternatives were recommended, three of the alternatives—A2: Palo Alto Phase 3 extended to Foothills, A4: Mountain View, and A6: East Palo Alto—were the highest-ranking alternatives.

Alternative A2, the highest ranked conceptual alignment, includes six pump stations and a 1.6-MG storage tank within the Palo Alto RWQCP service area. Pump stations were preliminarily located at the intersections of El Camino Real (Highway 82) and Oregon Expressway, Arastradero Road at Deer Creek Road, Page Mill Road at Arastradero Road, Moffett Field, Charleston Park, and at the Palo Alto RWQCP. Design phasing information and proposed facilities that make up each phase of Alternative A4 are described below.

Mountain View NPR+. Mountain View's 2014 Recycled Water Feasibility Study recommended a phased expansion of the Mountain View Recycled Water System. During Phase 1, approximately 16,700 linear feet (LF) of pipeline in the National Aeronautics and Space Administration (NASA) and Bay View areas, two variable frequency drive units, and a potable backup supply at the RWQCP. Phase 2 adds 9,900 LF of pipe in the Whisman Station and North Whisman neighborhoods, three pump stations, a 1.6-MG tank at NASA, and a 2.9-MG tank at Charleston Park. Phase 3 adds 16,200 LF of pipe to serve Sylvan Park, Cuesta Park, El Camino Hospital, and Cooper Park; and three variable-frequency drive units.

Sunnyvale NPR. NPR was studied by the City of Sunnyvale as part of the Feasibility Study for Recycled Water Expansion (FSRWE). This document identified multiple NPR projects to add up to 2,100 AFY of NPR demand within the City and Cupertino. Valley Water also has the ability, through its existing agreements, to wholesale NPR within its portion of the service area. Additional information about the NPR projects is further detailed in Section A.2 of Appendix F.

SBWR NPR+. NPR demands were updated so that SBWR delivered the projected 2040 recycled water demands identified in Table 2 of Appendix E-1. This resulted in delivery of approximately 2,810 AFY to the City of Milpitas, 9,500 AFY to SJ Muni, 9,000 AFY to the City of Santa Clara, and 9,625 AFY to San Jose Water. Combined, these buildout NPR demands total 30,935 AFY.

All existing demands as of the 2017 calendar year were placed where recycled water meters are currently located. Those actual demands were specifically located based on available information. Peaking factors consistent with existing demands were applied to all buildout demands.

For each retailer, demands were updated as follows:

- *City of Milpitas:* Existing City of Milpitas demands were 1,121 AFY. An additional 1,689 AFY were located at multiple points of connection where the City of Milpitas planned a new recycled water project, which is shown on Figure A.8 in Appendix F. No scaling up of demands were required for City of Milpitas NPR demands.
- *San Jose Water Company:* Existing San Jose Water Company (SJW) NPR demands are 2,697 AFY. Planned recycled water projects add an additional 5,703 AFY of NPR demands. Planned NPR demands were located at specific nodes in the hydraulic model where a turnout between the SBWR system and a future SJW pipeline would be located. To achieve the 9,625 AFY at buildout, an additional 1,225 AFY of demand was applied by scaling up existing and planned NPR demands throughout the SJW service area. See Figure A.7 in Appendix F for proposed alignments.
- *San José Municipal Water System:* Existing NPR demands in the North San José (1,231 AFY) and Edenvale (3,893 AFY) areas of the SJ Muni were continued in the buildout model. SJ Muni projected that additional growth of recycled water would exclusively occur within the North San José service area, and no additional growth was expected in Edenvale. SJ Muni provided a map of locations and magnitude of planned recycled water demand of approximately 1,060 AFY within its North San José service area. An additional 3,316 AFY of demand was not located. To achieve the desired buildout demand of 9,500 AFY within the SJ Muni service area and keep Edenvale demands consistent, the existing demand of 1,231 AFY was scaled up by 3,316 AFY to 4,547 AFY and located at the same location as existing demands.
- *City of Santa Clara:* Existing City of Santa Clara NPR demands of 5,050 AFY were continued in the buildout model. The City of Santa Clara provided a list of and location for an additional 1,534 AFY of recycled water demand from known potential projects in its distribution system. The City indicated that it expects any additional NPR demand (2,416 AFY) outside of existing and potential projects to be located north of Highway 101 and an area near Arques Drive. To achieve the desired buildout demand of 9,000 AFY, existing and proposed demands north of Highway 101 and near Arques Drive were scaled up from their identified values.

Gilroy NPR. The South County Recycled Water Master Plan (RWMP) explored NPR expansion and identified the potential to serve approximately 1,120 AFY of NPR demand by extending the existing recycled water distribution system in Gilroy. Additional information about this concept is further detailed in Section A.4 of Appendix F.

Morgan Hill NPR. The South County Recycled Water Master Plan (RWMP) explored NPR expansion and identified the potential to serve approximately 785 to 2,900 AFY of NPR demand in Morgan Hill via a satellite WWTP producing NPR water or by extending the existing recycled water distribution system in Gilroy north to Morgan Hill. Additional information about this concept is further detailed in Section A.4 of Appendix F. The South County RWMP did not recommend any NPR projects in Morgan Hill. Because NPR in Morgan Hill may be feasible in the context of an integrated countywide plan, potential NPR projects are considered in context of the project portfolios (Section 3.2).

Countywide NPR/NPR+. Table 2-16 presents a summary of potential future NPR and NPR+ projects and associated capital costs as previously studied by retailers in recycled water master plans. Demands shown in this table are not aligned with water suppliers' UWMP NPR/NPR+ demand projections. Existing demands are not reflected in Table 2-16.

Each retailer has different assumptions for what is included in its cost estimates; thus, NPR/NPR+ costs across agencies are not directly comparable. For example, capital costs in this table may or may not include soft costs, retrofits, treatment plant upgrades, pump stations, and/or storage. Some projects identified in Table 2-16 may require the implementation of other projects to feasibly proceed. Additionally, the capacity to provide recycled water during max day or peak hour conditions has not been confirmed.

Table 2-16. Potential Future NPR/NPR+ Projects and Cost Estimates for Recycled Water System Expansions

Retailer	Source Information					Capital Cost 2020 Dollars ($M)[d]	Annualized Capital Unit Cost ($/AF)
	ID	Project Name[a, b, c]	Year	Demand (AFY)	Capital Cost ($M)		
Palo Alto[e]	NPR-1	A1: Palo Alto Phase 3	2019	800	$47.8	$48.5	$3,100
	NPR-2	A2: Palo Alto Phase 3 Ext. to Foothills	2019	1,100	$63.0	$63.9	$3,000
	NPR-3	A3: Palo Alto Phase 3 Ext. to Foothills and Los Altos	2019	1,200	$85.1	$86.4	$3,700
Palo Alto NPR+ subtotal				1,200			
Mountain View	NPR-4	A4 – Phase 1 Short-Term Expansion	2014	588	$4.9	$5.7	$500
	NPR-5	A4 – Phase 2 Mid-Term Expansion	2014	316	$18.8	$22.0	$3,600
	NPR-5a	A4 – Phase 2 Long-Term Expansion	2014	221	$4.6	$5.4	$1,200
Mountain View NPR+ subtotal				1,125			
East Palo Alto	NPR-6	A6: East Palo Alto	2019	500	$20.7	$21.0	$2,100
East Palo Alto NPR+ subtotal				500			
PA/MV RWS Subtotal				2,825			
Sunnyvale[f]	NPR-7	Lakehaven Drive	2013	86	$1.41	$1.7	$1,000
	NPR-8	Maude Avenue	2013	36	$1.36	$1.6	$2,300
	NPR-9	Duane Avenue	2013	429	$5.62	$6.7	$800
	NPR-10	Kifer Road East	2013	51	$1.33	$1.6	$1,600
	NPR-11	Kifer Road West	2013	54	$0.78	$0.9	$900
	NPR-12	Main Loop	2013	335	$15.9	$19.1	$2,900
	NPR-13	Iris Avenue	2013	55	$0.63	$0.8	$700
	NPR-14	Marion Way	2013	30	$0.65	$0.8	$1,300
	NPR-15	Dartshire Way	2013	65	$1.37	$1.6	$1,300
	NPR-16	Gail Avenue	2013	39	$0.58	$0.7	$900
	NPR-17	Old San Francisco Road	2013	26	$0.45	$0.5	$1,100
	NPR-18	Manet Drive	2013	86	$0.45	$0.5	$300
	NPR-19	Sunnyvale-Saratoga Road	2013	14	$0.60	$0.7	$2,600
	NPR-20	Remington Drive	2013	59	$1.75	$2.1	$1,800
	NPR-21	Carson Drive	2013	16	$0.37	$0.4	$1,400
Sunnyvale NPR subtotal				1,381			
Sunnyvale RWS Subtotal				1,381			
Milpitas[g]	NPR-22	Segments 1 through 5	2016	751	$45	$49.3	$3,400
Milpitas NPR+ subtotal				751			
SJW[h]	NPR-23	Alignment L: Lewis Street	2011	589	$10.4	$12.9	$1,100
	NPR-24	Alignment P: Quimby Road	2011	1,731	$38.3	$47.6	$1,400
	NPR-25	Alignment K: West Hedding	2011	184	$4.27	$5.3	$1,500
	NPR-26	Alignment Q: Curtner	2011	2,421	$58.2	$72.4	$1,500
	NPR-27	Alignment I: Dolores	2011	70	$1.92	$2.4	$1,700
	NPR-28	Alignment E: Mabury Road (Phases 1 and 2)	2017	1,147	$15.0	$16.4	$700
	NPR-29	Alignment J: Saratoga	2011	97	$3.07	$3.8	$2,000
	NPR-30	Cupertino Extension	2012	2,100	$55.0	$67.3	$1,600
SJW NPR+ subtotal				8,339			

Table 2-16. Potential Future NPR/NPR+ Projects and Cost Estimates for Recycled Water System Expansions

Retailer	Source Information					Capital Cost 2020 Dollars ($M)[d]	Annualized Capital Unit Cost ($/AF)
	ID	Project Name[a, b, c]	Year	Demand (AFY)	Capital Cost ($M)		
SJ Muni	N/A	No specific projects. This is a buildout projection.	N/A	3,316	N/A	N/A	N/A
	N/A	Identified future customers (see Appendix C)	N/A	1,060	N/A	N/A	N/A
SJ Muni NPR+ subtotal				4,376			
Santa Clara	N/A	No specific projects. This is a buildout projection.	N/A	2,312	N/A	N/A	N/A
	N/A	Identified future customers (see Appendix C)	N/A	1,638	N/A	N/A	N/A
Santa Clara NPR+ subtotal				3,950			
SBWR Subtotal				17,416			
Gilroy[i]	NPR-31	Immediate Term Projects	2016	672	$14.3	$15.9	$1,200
	NPR-32	Short-Term Projects	2016	224	$9.97	$11.1	$2,500
	NPR-33	Long-Term Projects	2016	224	$10.0	$11.1	$2,500
Gilroy NPR subtotal				1,120			
Morgan Hill[i]	NPR-34	Options MH-1 and MH-2 (1 mgd with SCRWA transmission main)	2016	345-495	$41-48	$45.7-53.5	$4,700-$7,900
	NPR-35	Options MH-1 and MH-5 (1 mgd with Morgan Hill trunk line scalping plant)	2016	345-495	$33.8-$37.4	$37.7-$41.7	$3,900-$6,200
	NPR-36	Options MH-3 and MH-4 (2.25 mgd buildout with SCRWA transmission main)	2016	785	N/A	N/A	N/A
	NPR-37	Options MH-6 and MH-7 (2.25 mgd buildout with Morgan Hill trunk line scalping plant)	2016	785	N/A	N/A	N/A
	NPR-38	Market assessment (total potential NPR)	2016	2,877	N/A	N/A	N/A
Morgan Hill NPR subtotal				345- 2,877			
SCRWA Subtotal				1,465-3,997			
Countywide NPR/NPR+ TOTAL				23,087- 25,619			

a. All projects are listed to the extent feasible. Not all projects can be implemented independently. Some projects may require other projects (pipelines, tanks, pump stations, treatment plants, or retrofits) to be completed.

b. Source projects that combined IPR or DPR with NPR projects are not listed in this table.

c. The projects presented in this table are not mutually exclusive. Some projects were originally presented as options that may have included portions of other projects also presented in this table.

d. Cost escalation is based on California Construction Cost Index (CCCI) from Department of General Services (https://www.dgs.ca.gov/RESD/Resources/Page-Content/Real-Estate-Services-Division-Resources-List-Folder/DGS-California-Construction-Cost-Index-CCCI). Original CCCI were taken from dates of reference document and escalated using April 2020 CCCI of 6955.

e. For the Palo Alto RWQCP, all information was taken from the Recycled Water Strategic Plan Report – Northwest County Recycled Water Strategic Plan, Interim Final Report, July 2019. It was assumed this information superseded reports by various retailers in this service area.

f. For the Sunnyvale WPCP, all information came from the Feasibility Study for Recycled Water Expansion, June 2013.

g. For Milpitas, source is City of Milpitas Recycled Water Pipeline Project Final IS/MND, October 2016.

SJW segments were from RWMP Update, 2011. SJW Alignment E cost and demands were updated in 2017.

Gilroy and Morgan Hill projects do not include planned SCRWA WWTP project costs. All data comes from the 2015 South County Recycled Water Master Plan Update, May 2016

Figure 2-15 shows the NPR/NPR+ expansions that have been identified from various planning reports or in collaboration with agencies.

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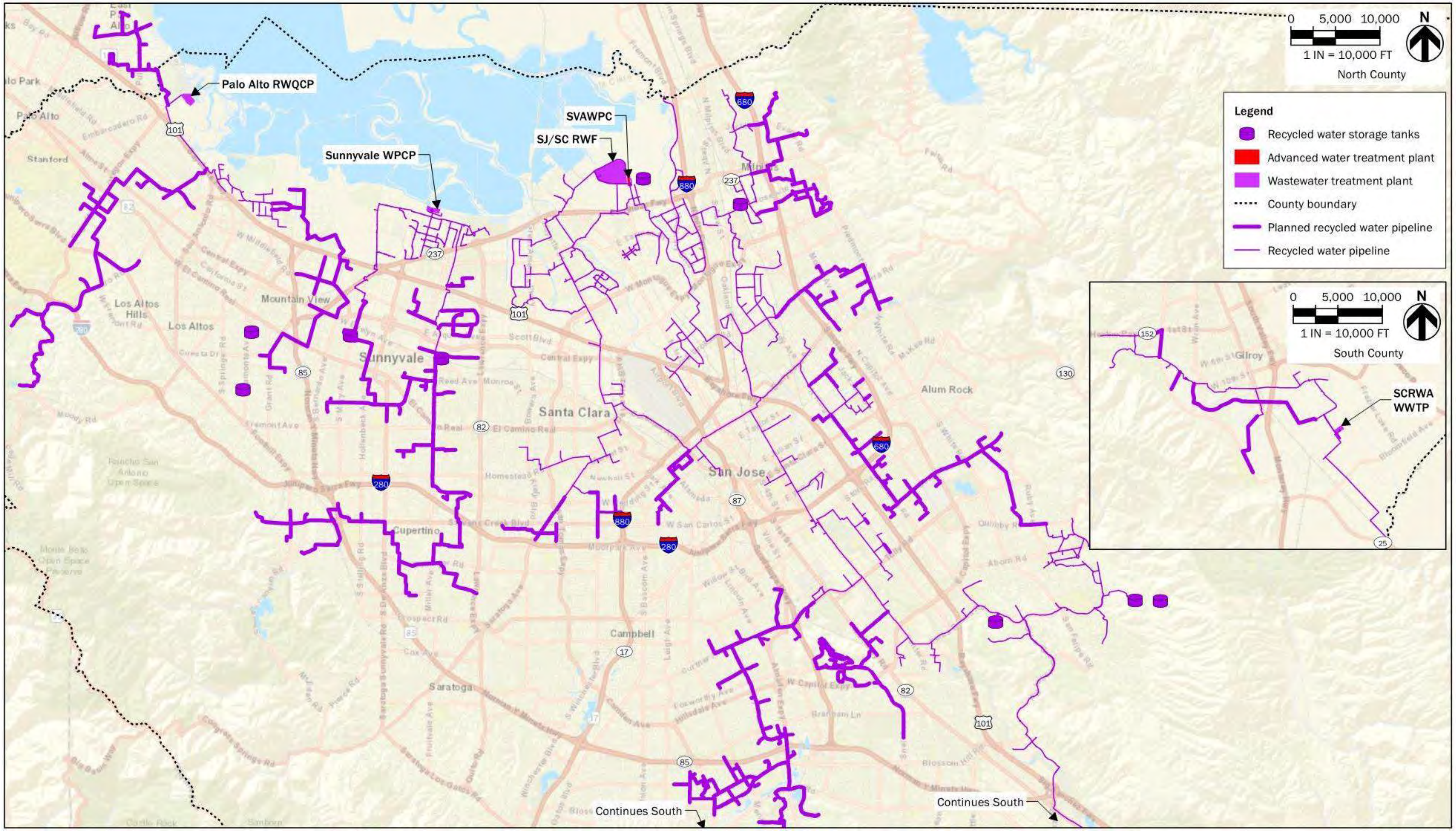

Figure 2-15. Expansion of existing NPR/NPR+ distribution systems Countywide

Note: City of Santa Clara and SJ Muni recycled water infrastructure improvements are currently undefined.

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2.3.2 Interties between Recycled Water Systems

The interconnection of recycled water systems has several potential functions, including:

1. **Reliability:** If an outage occurs in one system, available capacity from an adjoining system could be used. Supply from an adjoining system could also support pipeline maintenance activities, such as shutdowns of transmission mains.
2. **Peak demand supply mitigation:** Peak day and peak hour demands are a challenge in some systems, and supply from an adjoining system could be leveraged to meet demands.
3. **Freeing up effluent for PR:** By meeting NPR demands of adjacent systems, the amount of supply offset could provide more flow for PR or ROC dilution. For example, if Sunnyvale's NPR demand was met by SBWR, Sunnyvale could provide more supply for PR or ROC dilution. Vice versa, if SBWR's NPR+ expansion was met using effluent from Sunnyvale, SBWR would be able to confidently meet NPR+ demands even during dry years, allowing for supply for PR.

Interties may require pump stations, pressure-reducing valves, or other facilities depending on the function and operation. Additionally, interties between recycled water distribution systems would need to be accompanied by treatment improvements (i.e., an AWPF for NPR+) to avoid negatively impacting the water quality of a neighboring system. Pipeline alignments have been studied for four intertie opportunities in North County, as summarized in Table 2-17 and shown in Figure 2-16.

Table 2-17. Summary of Potential Recycled Water System Interties

Alignment	Description	Key Assumptions/Features	Pipe Length/ Diameter	Capital Cost (2019$)	Source
Sunnyvale – SBWR Interties					
Effluent intertie	Proposed 30-inch pipeline to convey secondary effluent from the Sunnyvale WPCP to the SJ/SC RWF or SVAWPC	5 trenchless crossings 50% of alignment requires tunneling due to Bay soils and high groundwater Sizing assumes 10 mgd; actual flow availability to be determined through discussions with Sunnyvale	32,000 LF 30”	$86M	See footnote (e)
Recycled water intertie, northern connector [a]	Connection of existing SBWR 30-inch pipeline located at Lafayette Drive and Tasman Road to an existing 24-inch Sunnyvale pipeline at Sunnyvale East Channel and Persian Drive Hydraulically modeled to deliver peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale	2 trenchless crossings (Guadalupe River and Calabazas Creek)	16,000 LF 24”	$14.5M	See footnote (b)
		1 trenchless crossing	15,000 LF 30”	$23M	See footnote (c)
		4 trenchless crossings 50% of alignment requires tunneling due to Bay soils and high groundwater Modeling indicates new pump station is necessary to connect to SBWR		$51.1M	See footnote (e)
Recycled water intertie, southern connector [a]	Connection of existing 16-inch SBWR pipeline at Homestead Rd and Las Palmas Dr to existing Wolfe Rd pipeline Hydraulically modeled to deliver peak recycled water demand of 2.7 mgd from SBWR to Sunnyvale	2 trenchless crossings	12,000 LF 16”	$7M	See footnote (b)
		3 trenchless crossings Modeling indicates alignment would result in a large pressure increase in the SBWR system; cost and detailed alignment analysis was not performed	12,000 LF 30”	Not prepared	See footnote (e)
Sunnyvale – Mountain View intertie					
Recycled water intertie	Connection of existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field that would connect to the Mountain View recycled water distribution system	Pipeline could serve new customers in Mountain View’s North Bayshore area and within NASA and the Bay View area outside the existing service area.	18,600 LF 16”	$16M	See footnote (d)

a. *Sunnyvale-SBWR recycled water interties require an AWPF for NPR+ in Sunnyvale to reduce salinity to levels consistent with SBWR. As presented, estimated capital costs are not inclusive of such an AWPF in Sunnyvale.*

b. *TM2: Modeling of Regional Sunnyvale/ SBWR Recycled Water Distribution System HydroScience 2011*

c. *San Jose Water, 2011. Recycled Water Master Plan – 2011 Update Draft. Prepared by HydroScience Engineers, Inc.*

d. *City of Mountain View, 2014. Recycled Water Feasibility Study. Prepared by Carollo Engineers.*

e. *Sunnyvale Source Water Augmentation Facilities Plan, RMC 2018*

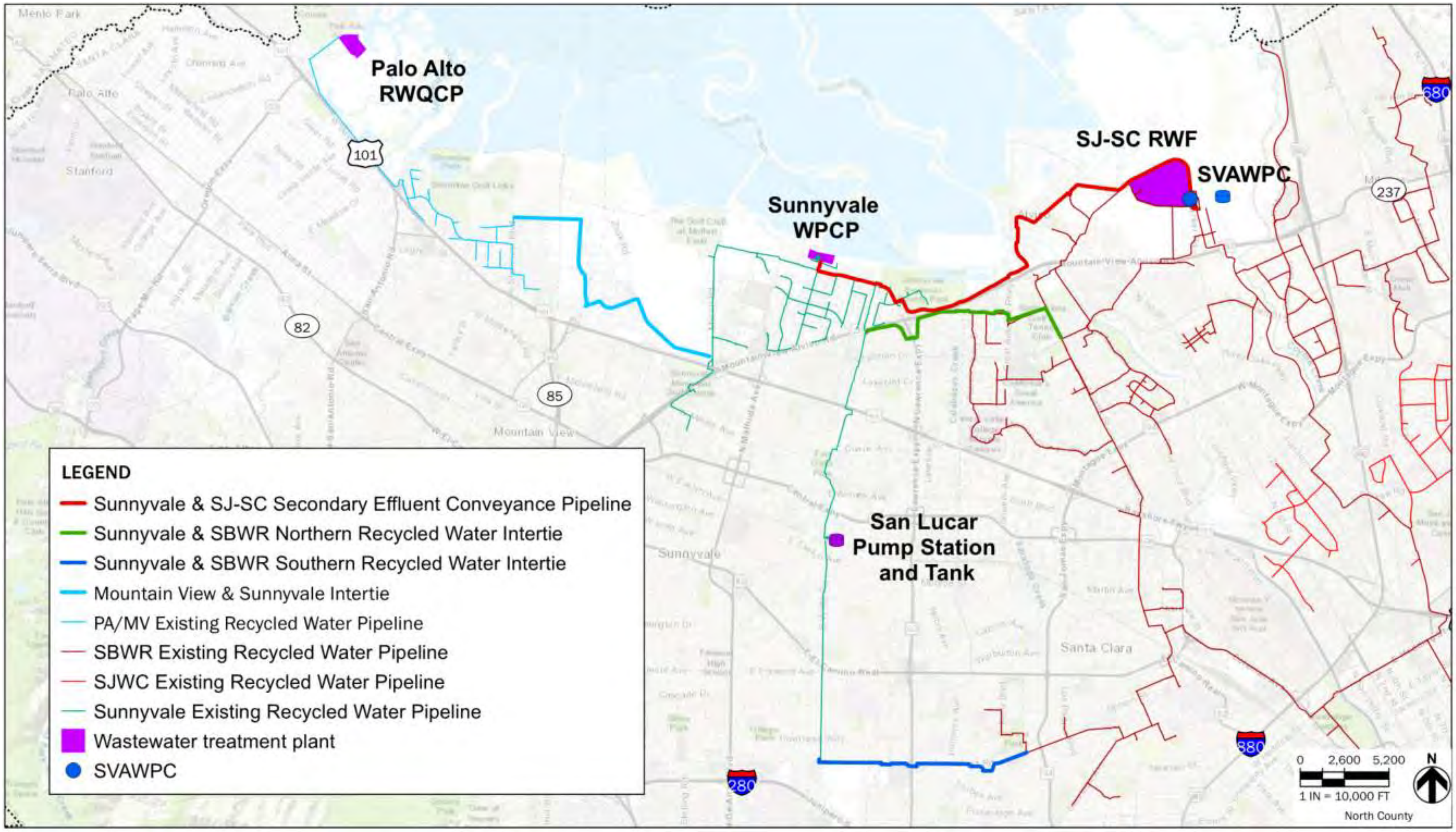

Palo Alto RWQCP
SJ-SC RWF
SVAWPC
Sunnyvale WPCP
San Lucar Pump Station and Tank
101
82
85
237
680
880
280
Menlo Park
Palo Alto
Stanford
Mountain View
Sunnyvale
Santa Clara
LEGEND
Sunnyvale & SJ-SC Secondary Effluent Conveyance Pipeline
Sunnyvale & SBWR Northern Recycled Water Intertie
Sunnyvale & SBWR Southern Recycled Water Intertie
Mountain View & Sunnyvale Intertie
PA/MV Existing Recycled Water Pipeline
SBWR Existing Recycled Water Pipeline
SJWC Existing Recycled Water Pipeline
Sunnyvale Existing Recycled Water Pipeline
Wastewater treatment plant
SVAWPC
0 2,600 5,200
1 IN = 10,000 FT
N
North County

Figure 2-16. Potential recycled water system interties

2.3.3 PR Conveyance Infrastructure

PR conveyance elements include effluent pipelines that send source water from WWTPs to treatment facilities, purified water pipelines that send purified water from treatment facilities to delivery points, pump stations that push/pull water through these pipelines, and delivery point improvements, such as pipeline rehabilitation and the installation of new tanks and pumps.

Effluent Pipelines

One possible alignment was considered for each effluent pipeline due to infeasibility of other potential alternative alignments in each location.

- A new 36-inch pipeline from the Palo Alto RWQCP to the proposed Palo Alto Regional AWPF sized to be able to convey 18.1 mgd of effluent to produce 14 mgd of purified water.
- A new 36-inch effluent pipe from the Sunnyvale WPCP to the proposed Palo Alto Regional AWPF would convey 13.6 mgd of effluent to produce 10.5 mgd of purified water.
- A new 36-inch effluent pipeline from the Palo Alto RWQCP to the proposed Sunnyvale Regional AWPF would convey 18.1 mgd of effluent to produce 14 mgd of purified water.
- A new 36-inch effluent pipe from the Sunnyvale WPCP to the proposed Sunnyvale Regional AWPF would convey 13.6 mgd of effluent to produce 10.5 mgd of purified water. The Sunnyvale WPCP is located across the street from the proposed Sunnyvale AWPF.
- A new 48-inch pipeline to convey secondary or tertiary effluent from the SJ/SC RWF to the San José AWPF. The pipeline would convey flow from either the existing secondary clarifiers or tertiary filters to the influent pump station of the San José AWPF.

Purified Water Pipelines

Palo Alto AWPF to LGRP: Four alignments to convey purified water from the Palo Alto AWPF site to LGRP were evaluated. Each of these route variations offers potential advantages; key considerations for each alignment are summarized below.

- **Eastern route, via Sunnyvale WPCP.** This route would use the alignment recommended in the Expedited Purified Water Program Plan (for transporting purified water from San José to LGRP). Though this alignment has the longest length of any purified water option extending from Palo Alto to LGRP, it offers potential to easily add purified supply from SJ/SC RWF in the future due to its central location.
- **Western route, via Sunnyvale WPCP.** As considered in the Sunnyvale FSRWE, this alternative would use the Wolfe Road pipeline as a purified water supply. This alternative does not require trenchless construction to cross Highway 280. Though adding purified supply from SJ/SC RWF would require a longer purified water pipeline, this route is closest to Rinconada WTP, which could enable future RWA.
- **Western route, bypassing Sunnyvale WPCP.** In addition to requiring a shorter pipeline than options going through Sunnyvale WPCP, this route would not require trenchless construction for crossing Highways 280, 101, and 237; however, trenchless construction would be needed to cross a creek, Valley Transit Authority, and San Francisco Public Utilities Commission (SFPUC) facilities. Though adding purified supply from SJ/SC RWF would require a longer purified water pipeline, this route is closest to Rinconada WTP, which could enable future RWA.
- **Eastern route, bypassing Sunnyvale.** This is the shortest pipeline option of any alternative. Crossing Highways 237 and 101 would not require trenchless construction, though it would be required to cross Highway 280, a creek, Valley Transit Authority, and SFPUC facilities. South of Arques, this option mirrors the Expedited Purified Water Program Plan recommended alignment.

Palo Alto AWPF to West Pipeline (TWA): A new pipeline would convey purified water treated for TWA almost 11 miles to a delivery point along Valley Water's existing West pipeline.

Sunnyvale AWPF to LGRP: Two purified water alignments from the Sunnyvale AWPF to LGRP were considered. Starting at the Sunnyvale AWPF, these alignments are identical to the eastern and western route (via Sunnyvale) considered for conveying purified water from the Palo Alto AWPF to LGRP. These purified water alignment options (eastern and western) were studied in the Expedited Purified Water Program Plan (Valley Water, 2018) and Sunnyvale's Feasibility Study for Recycled Water Expansion Report (City of Sunnyvale, 2013b).

San José AWPF to LGRP. One purified water pipeline alignment is recommended from the San José AWPF to LGRP based on an alignment studied in the Expedited Purified Water Program Plan (Valley Water, 2018). A new 48-inch, 18-mile pipeline would convey up to 24 mgd of purified water.

San José AWPF to SBA terminal tank (RWA). One purified water pipeline alignment is recommended from the San José AWPF to the SBA terminal tank at the Penitencia WTP as previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018). A new 48-inch, 9-mile pipeline would convey up to 24 mgd of purified water.

San José AWPF to North Side Tanks (TWA). One new purified water pipelines alignment is recommended from the San José AWPF to North Side Storage Tanks to serve the cities of San José and Santa Clara (portions north of Highway 101). A new 24-inch, 5-mile pipeline would convey about 4 mgd of purified water.

San José AWPF to Milpitas Pipeline (TWA). One purified water pipeline alignment is recommended from the San José AWPF to the Gilbraltar Reservoir where water could be introduced to the Milpitas Pipeline. A new 36-inch, 4-mile pipeline would convey up to 20 mgd of purified water.

San José AWPF to Piedmont Valve Yard (TWA). One purified water pipeline alignment is recommended from the San José AWPF to the Piedmont Valve Yard where water could be introduced to the Milpitas Pipeline or Valley Water's East pipeline. A new 36-inch, 8-mile pipeline would convey up to 20 mgd of purified water.

Pump Stations

Palo Alto. One effluent pump station would be needed to deliver effluent from the Palo Alto RWQCP to a new AWPF in Palo Alto; if also supplied by the Sunnyvale WPCP, an additional effluent pump station (located at Sunnyvale WPCP) would be needed. One purified water pump station, located at the Palo Alto AWPF, would be required to pump purified water to LGRP.

Sunnyvale. One purified water pump station is needed to deliver water from a Sunnyvale AWPF to LGRP. Assuming the Sunnyvale AWPF is located at Recycle Hill, an effluent pump station would be necessary to supply Palo Alto RWQCP effluent to the Sunnyvale AWPF (but not from Sunnyvale WPCP to the Sunnyvale AWPF).

San José. A pump station would be required to deliver approximately 24 mgd to a total dynamic head (TDH) of approximately 585 feet. If located at the San José AWPF, there would be no booster pump stations between the AWPF and the Penitencia WTP.

Other Conveyance Infrastructure

LGRP Improvements. The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water. These improvements were previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018).

Penitencia WTP Improvements. Upgrades to the existing Penitencia WTP would be required for it to accept purified water. These improvements were previously evaluated as part of the Expedited Purified Water Program Plan (Valley Water, 2018).

Rinconada WTP Extension. A pipeline extension from LGRP to Rinconada WTP would allow the option to use GWR infrastructure for RWA. No WTP improvements were assumed to be needed at Rinconada.

Section 3: Portfolio Development

The development of portfolios (formerly called alternatives) began in 2018 with identifying five conceptual portfolios and engaging Partner Agencies to select three conceptual portfolios and a variety of project elements for further development and evaluation. The project elements described and detailed in Section 2 represent those with the highest interest, most likely feasibility, and/or ability to meet partner and program goals.

While project elements were developed individually (with separate cost estimates shown in Appendix A-6), they can be combined in a variety of ways to create Countywide reuse portfolios for comparison on an economic, regulatory, institutional, and environmental basis. For the purpose of this TM, project elements are grouped and evaluated as follows.

- **NPR/NPR+ distribution system expansion** applies consistently across all portfolios and is, therefore, not considered a differentiator in the portfolio evaluation (Section 5).
- **South County reuse options** can be included in combination with any portfolio and, therefore, are evaluated separately from the portfolios (in Section 5.3).
- **Baseline elements** comprise each portfolio and are evaluated collectively by portfolio.
- **Alternative elements** are options that have been explored and remain separate from portfolios as possible “add-on” items (e.g., interties) or substitutions (e.g., alternative alignments). These elements are included for consideration due to their potential benefits, though they are not included in the evaluation in Section 5, which focuses on comparing the differences among portfolios.

With a major goal of producing 24,000 AFY of PR, the conceptual portfolios selected for this evaluation each included a major PR project element(s) with source flow from the major North County WWTPs, including the SJ/SC RWF, Palo Alto RWQCP, and Sunnyvale WPCP. Using flows from these major facilities is the only way to potentially meet the 24,000 AFY goal. The core element of the three portfolios include:

- Portfolio 1: San José AWPF
- Portfolio 2: Combined Palo Alto/Sunnyvale Regional AWPF for GWR at LGRP
- Portfolio 4: Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP

The following sections present and compare the NPR projects, the South County opportunities, and core project elements of the three portfolios.

3.1 NPR/NPR+ Expansion (Featured in All Portfolios)

NPR/NPR+ expansion is expected to occur throughout the County and be implemented in numerous water retailer service areas. NPR use and economics associated with expansion evolve over time, and new opportunities arise with changes in land use and business-driven development or redevelopment. A significant industrial NPR demand, such as a cooling tower for a data center, is likely a cost-effective investment to serve. Company/business-driven sustainability initiatives also provide private funding to support water reuse infrastructure implementation.

Other benefits of NPR are that it can minimize the need to increase potable water system capacity and treatment and, relative to producing water for PR, is often a lower-cost water supply to produce from an energy and chemical perspective.

3.2 Portfolio 1 - San José AWPF

Portfolio 1 is centered on using available effluent from the SJ/SC RWF and a new AWPF located adjacent to the existing SVAWPC in San José. Relevant AWPF project elements described in Section 2 identify delivery points for GWR, RWA, and TWA. Corresponding project elements include a PR conveyance pipeline from the AWPF to the delivery points, and infrastructure improvements at the delivery point for integrating purified water into supply/existing systems. The following sections summarize the PR project elements for the four portfolios and the capital and O&M cost estimates.

3.2.1 Portfolio 1a – San José AWPF for GWR (LGRP)

Portfolio 1a delivers up to 24,000 AFY to LGRP for groundwater replenishment (Figure 3-1). Regulations for this portfolio are established with at least nine GWR projects permitted and in operation throughout the state, and more than a dozen more in planning or construction.

The proposed 18-mile pipeline from the AWPF to LGRP would traverse through highly urbanized settings with significant utilities and temporary community disruption. Infrastructure improvements at LGRP would enhance the operational capabilities and allow some ponds to be taken out of service without impacting the entire complex. Using the LGRP system is attractive, as groundwater modeling indicates travel time to the nearest potable supply wells is more than 12 months.

Table 3-1 summarizes Portfolio 1a facilities.

Table 3-1. Portfolio 1a Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for GWR	Capacity	24	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	19,000	AFY	Long-term PR usage may be limited by groundwater basin capacity, based on Valley Water's WEAP modeling (Valley Water, 2019b)
Pump stations				
PS-1	Flow	16,700	gpm[a]	Purified water delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-2	Diameter	48	in	Purified water from San José AWPF to LGRP
	Length	18.1	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018)
ROC management pipeline				
ROC management pipeline	Diameter	18	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

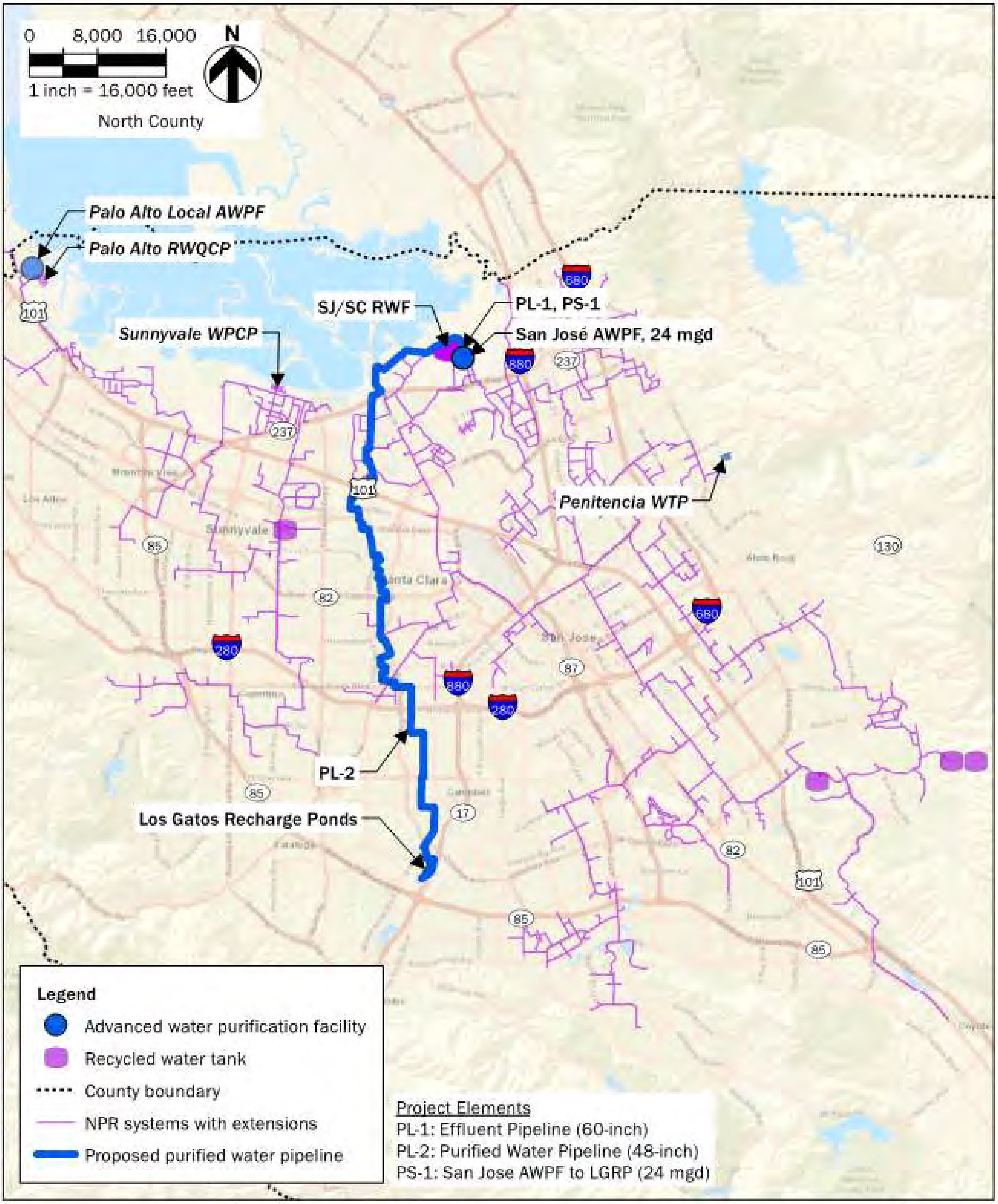


Figure 3-1. Portfolio 1a PR from San José AWPF for GWR (LGRP)

Table 3-2 contains estimated capital and annual O&M costs for Portfolio 1a elements, presented in 2019 dollars.

Table 3-2. Portfolio 1a Estimated Cost Summary from San José AWPF for GWR (LGRP)[a]

Element	Cost ($2019, in millions)	
	Capital	Annual O&M
AWPF (San José 24 mgd)	$320	$13.8
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to LGRP) LGRP improvements Pipeline easements	$315	$3.4
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$635	$19.6
ROC Management (existing outfall)	$20	$1.8
Total, with ROC Management	$655	$21.4

a. Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs

3.2.2 Portfolio 1b – San José AWPF for RWA (Penitencia WTP)

Portfolio 1b delivers up to 24,000 AFY to the SBA terminal tank located at Penitencia WTP. As discussed in Section 2, DDW is currently in the process of developing RWA regulations and expects to establish the regulations in 2023. Throughout the state, several projects are being discussed with regulators. Due to regulatory uncertainty, the preliminary design for the San José AWPF for RWA incorporates additional disinfection (ozone) and filtration (biologically active GAC) processes to the multi-process treatment train as the basis for planning and cost estimates.

Blending purified water into the SBA terminal tank and the associated pipeline connecting to the Penitencia FM would integrate purified water into Penitencia WTP and the Central Pipeline, which conveys water to the system that feeds Rinconada WTP. The Central Pipeline also has a turnout to the LGRP system. Based on Valley Water’s Water Evaluation and Planning System (WEAP) modeling, Portfolio 1b has the same groundwater replenishment benefits as the portfolios that deliver purified water directly to LGRP.

Compared with other portfolios, the connection to the raw water system supports multiple pathways for purified water to be used in various types of water years. The conveyance pipeline from the San José AWPF to Penitencia WTP would be approximately 9 miles—less than half the pipeline length required by other portfolios. Figure 3-2 shows the proposed pipeline path from the San José AWPF to the Penitencia WTP.

Table 3-3 summarizes Portfolio 1b facilities. Table 3-4 contains estimated capital and annual O&M costs for Portfolio 1b elements, presented in 2019 dollars.

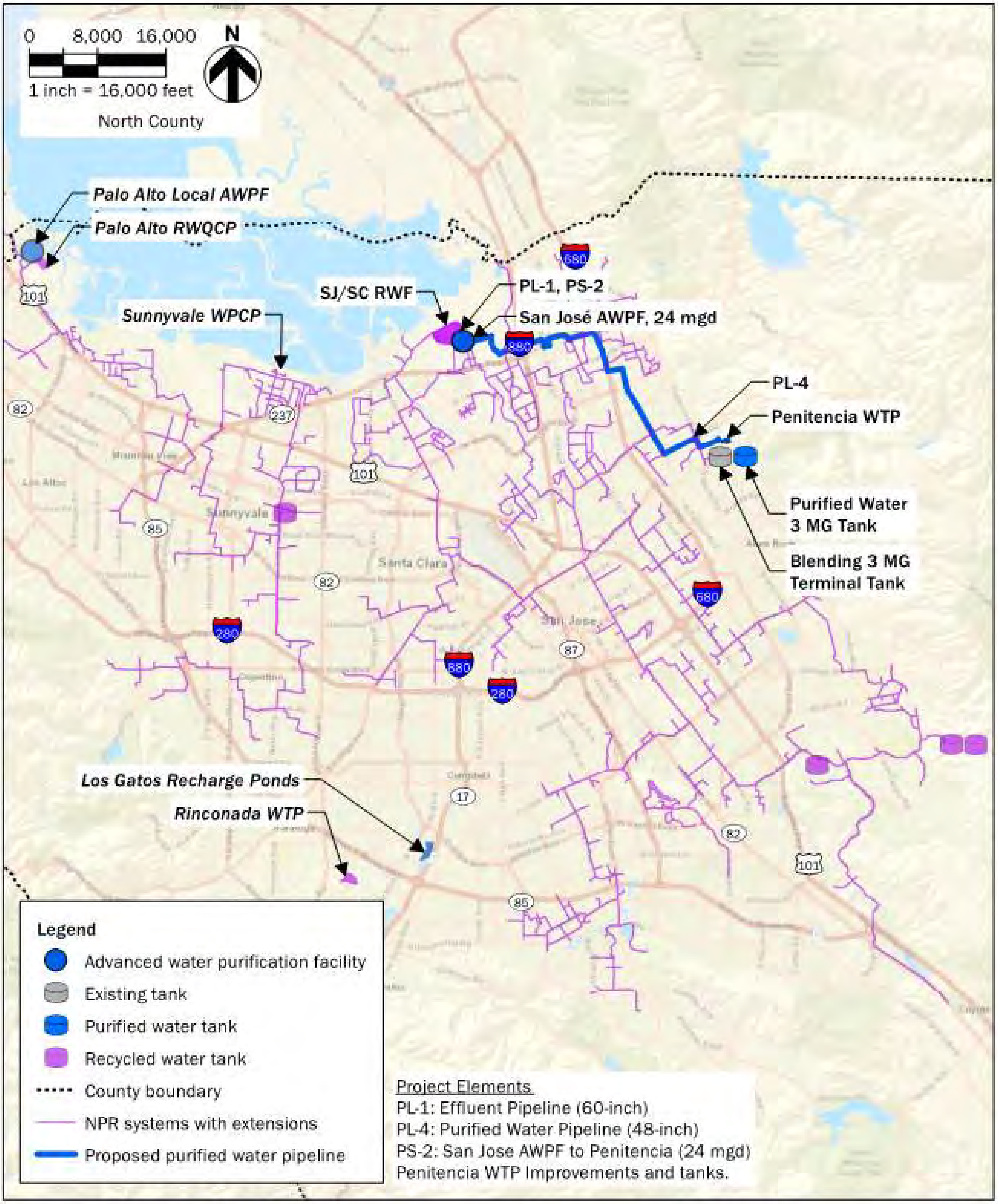


Figure 3-2. Portfolio 1b PR overview

Table 3-3. Portfolio 1b Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for RWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	19,800	AFY	Long-term PR usage may be limited by groundwater basin capacity (due to indirect groundwater benefits), based on Valley Water's WEAP modeling (Valley Water, 2019b)
Pump stations				
PS-2	Flow	16,700	gpm[a]	Purified water delivery to new 3-MG purified water storage tank[b]
	TDH	550	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-4	Diameter	48	in	Purified Water from San José AWPF to SBA at Penitencia WTP
	Length	8.9	miles	
Delivery point improvements				
Penitencia purified water storage	Volume	3	MG	
Penitencia sodium bisulfite system (storage and pump system)	n/a	n/a	n/a	Penitencia WTP already has a calcium thiosulfate system that may have capacity for this application
Blend pipe and pipelines	n/a	n/a	n/a	
ROC management pipeline				
ROC management pipeline	Diameter	18	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

b. 3-MG storage tank is sized to provide about 3 hours' worth of operational purified water storage at Penitencia. If the AWPF is offline, Valley Water could request a transfer from the State Water Project, which has an assumed 3- to 4-hour response time. (Valley Water, 2018)

Table 3-4. Portfolio 1b Estimated Cost Summary

Element	Cost ($2019, in millions)	
	Capital	Annual O&M
AWPF (San José 24 mgd for RWA)	$385	$16.0
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to Penitencia WTP) Penitencia WTP Improvements Pipeline easements	$245	$4.3
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$630	$22.7
ROC management (existing outfall)	$20	$1.8
Total, with ROC Management	$650	$24.5

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

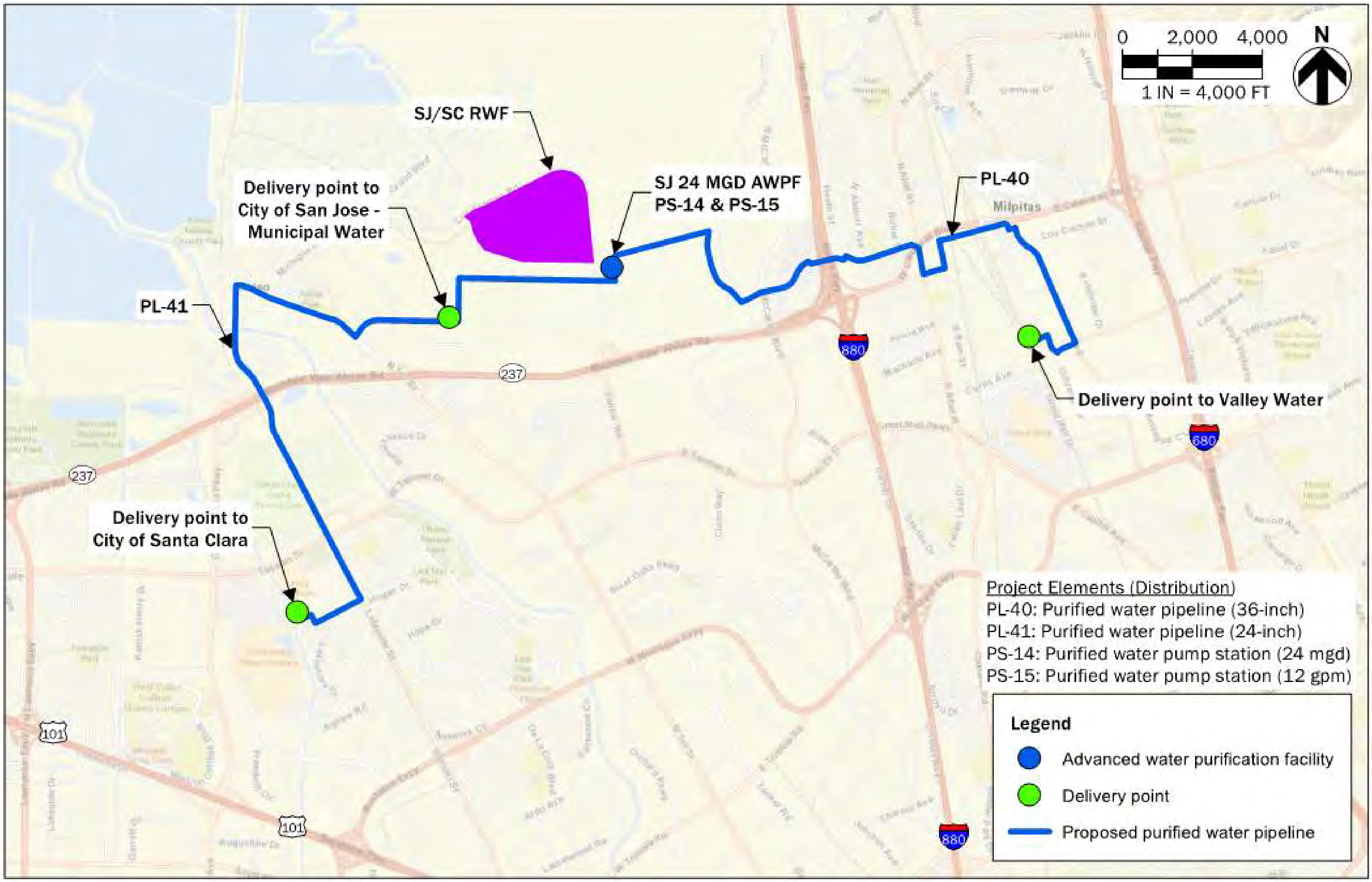
3.2.3 Portfolios 1c and 1d – San José AWPF for TWA

Portfolios 1c and 1d would both produce up to 24,000 AFY that could be used locally and/or conveyed down to the Piedmont Valve Yard for blending and distribution. As discussed in previous sections, DDW is currently in the process of developing DPR regulations. More detailed evaluation of blending ratios of purified water and other supplies at delivery points would need to be conducted in the future. Ensuring adequate systems are in place to protect against treatment and water quality issues that could lead to the distribution of off-spec (or potentially off-spec) water will be critical. To help mitigate some of these concerns, the design of the San José TWA AWPF's include baffled clearwells that should provide: (a) the ability to respond to upstream performance and water quality issues; (b) hydraulic buffering to manage demands in the distribution system; and (c) a location to divert off-spec water upstream of distribution.

The DPR framework identifies that alternative water supplies will be required for TWA. Back-up water supply is critical for reliability; systems need the ability to provide an alternate potable water supply on a similarly rapid timescale.

Compared to other portfolios, directly connecting to a potable water system supports multiple pathways for using purified water during various water year types. The purified water produced by these TWA portfolios will provide a new source of reliable, local, drought-resistant supply to Valley Water wholesale customers in Santa Clara County to bolster their existing water supply portfolios. Figures 3-3 and 3-4 show the proposed pipelines and general locations for introducing purified water to potable systems for Portfolios 1c and 1d, respectively. Both Portfolio 1c and 1d have pipelines sized to deliver approximately 4 mgd to the North Side Storage Tanks for use by the City of Santa Clara and SJ Muni water distribution systems north of Highway 101. Portfolio 1c and 1d differ in the method for conveying water to Valley Water's Piedmont Valve Yard (near Penitencia WTP) south to treated water turnouts along the East Pipeline. In Portfolio 1c, water would be conveyed via a new pipeline to the Gibraltar Reservoir at the north terminus of the existing Milpitas Pipeline for transport to Piedmont Valve Yard, while in Portfolio 1d a new pipeline would deliver water all the way to the Piedmont Valve Yard.

Tables 3-5 and 3-6 summarize Portfolios 1c and 1d facilities, respectively.


SJ/SC RWF
Delivery point to City of San Jose - Municipal Water
SJ 24 MGD AWPF PS-14 & PS-15
PL-40
Milpitas
PL-41
Delivery point to Valley Water
Delivery point to City of Santa Clara
237
880
680
101
0 2,000 4,000
1 IN = 4,000 FT
N

Project Elements (Distribution)
PL-40: Purified water pipeline (36-inch)
PL-41: Purified water pipeline (24-inch)
PS-14: Purified water pump station (24 mgd)
PS-15: Purified water pump station (12 gpm)

Legend
● Advanced water purification facility
● Delivery point
— Proposed purified water pipeline

Figure 3-3. Portfolio 1c PR from San José AWPF for TWA

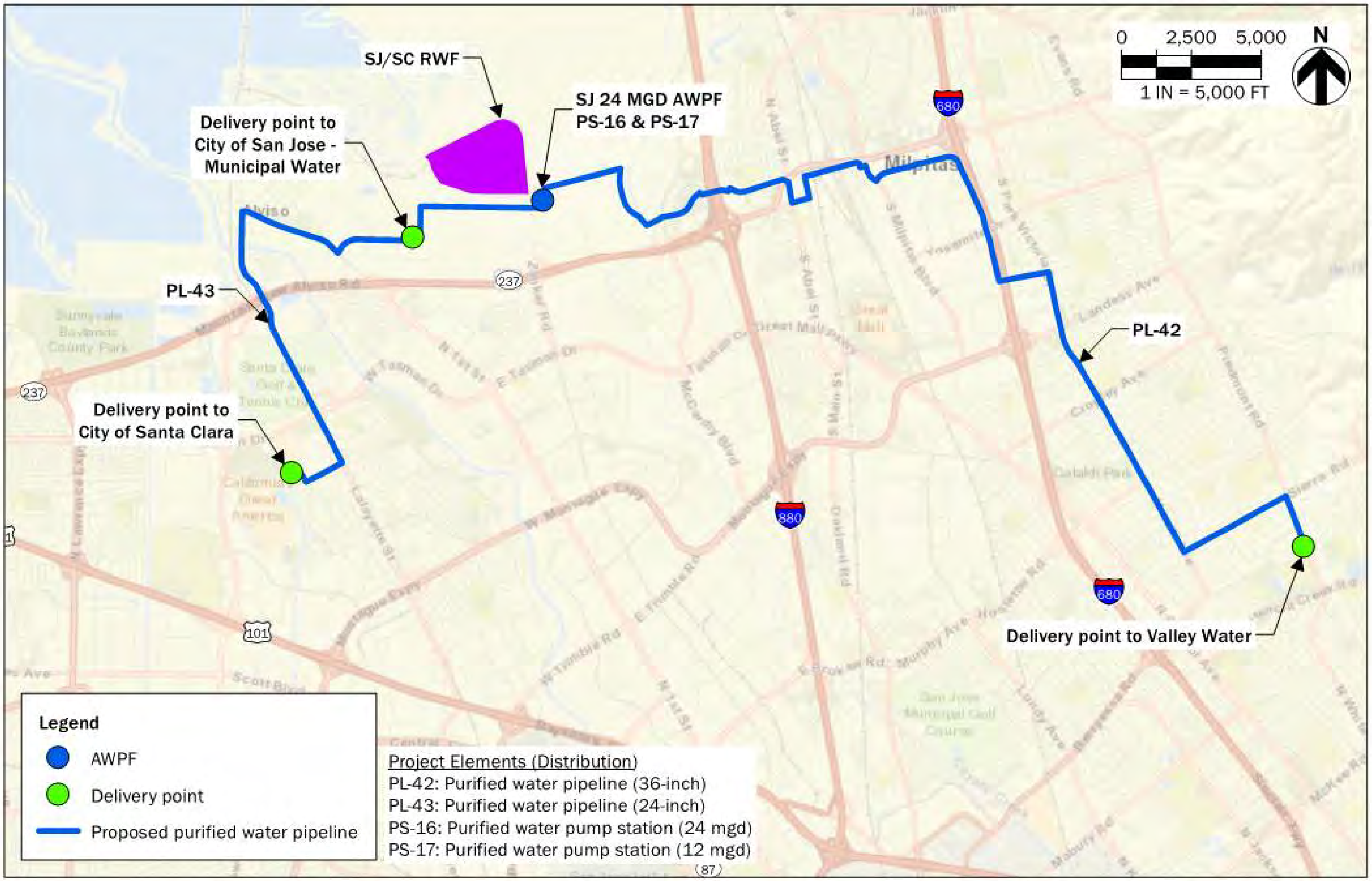

0 2,500 5,000
1 IN = 5,000 FT
N
SJ/SC RWF
SJ 24 MGD AWPF
PS-16 & PS-17
Delivery point to
City of San Jose -
Municipal Water
PL-43
Delivery point to
City of Santa Clara
PL-42
Delivery point to Valley Water
Alviso
Milpitas
237
880
680
101
87
Legend
● AWPF
● Delivery point
━ Proposed purified water pipeline
Project Elements (Distribution)
PL-42: Purified water pipeline (36-inch)
PL-43: Purified water pipeline (24-inch)
PS-16: Purified water pump station (24 mgd)
PS-17: Purified water pump station (12 mgd)

Figure 3-4. Portfolio 1d PR from San José AWPF for TWA

Table 3-5. Portfolio 1c Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for TWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	24,000	AFY	Assumes no delivery point limitations for TWA
Pump stations				
PS-14	Flow	16,700	gpm[a]	Delivery of treated water to Piedmont Valve Yard at Penitencia WTP
	TDH	350	ft	
PS-15	Flow	8,333	gpm[a]	Delivery to Santa Clara (North of Hwy 101)
	TDH	250	ft	
Effluent and purified water conveyance pipelines				
PL-1	Diameter	60	in	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-40	Diameter	36	in	Purified water from San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus
	Length	3.9	miles	
PL-41	Diameter	24	in	Purified water from San José AWPF to Santa Clara (North of Hwy 101)
	Length	4.7	miles	
ROC Management pipeline				
ROC Management pipeline	Diameter	18	in	
	Length	9,600	ft	

a. 1 gpm = 0.00144 mgd

Table 3-6. Portfolio 1d Facilities Summary

Element	Criteria	Quantity	Unit	Notes
San José AWPF for TWA	Capacity	24	mgd	
Annual yield				
Annual yield	Upper bound	24,000	AFY	Based on purified water production capacity
	Lower bound	24,000	AFY	Assumes no delivery point limitations for TWA
Pump stations				
PS-16	Flow	16,700	gpm[a]	Purified water delivery to Piedmont Valve Yard at Penitencia WTP
	TDH	350	ft	
PS-17	Flow	8,333	gpm[a]	Purified water delivery to Santa Clara (North of Hwy 101)
	TDH	250	ft	
Effluent and conveyance pipelines				
PL-1	Diameter	60	inch	Effluent from SJ/SC RWF to San José AWPF
	Length	2,000	ft	
PL-42	Diameter	36	inch	Purified water from San José AWPF to Piedmont Valve Yard at Penitencia WTP
	Length	8.2	miles	
PL-43	Diameter	24	inch	Purified water from San José AWPF to Santa Clara (North of Hwy 101)
	Length	4.7	miles	
ROC Management pipeline				
18-inch		9,600	ft	

a. 1 gpm = 0.00144 mgd

Tables 3-7 and 3-8 contain estimated capital and annual O&M costs for Portfolio 1c and 1d elements, presented in 2019 dollars, respectively.

Table 3-7. Portfolio 1c Estimated Cost Summary

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd for TWA)	$395	$16.3
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water [PS-14]) Pump station (San José AWPF, purified water [PS-15]) Purified pipeline (San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus at Penitencia WTP) Purified pipeline (San José AWPF to Santa Clara [North of Hwy 101]) Pipeline easements	$140	$3.6
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$535	$22.3
ROC Management (existing outfall)	$20	$1.8
Total, with ROC Management	$555	$24.1

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

Table 3-8. Portfolio 1d Estimated Cost Summary

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (San José 24 mgd for TWA)	$395	$16.3
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water [PS-16]) Pump station (San José AWPF, purified water [PS-17]) Purified pipeline (San José AWPF Piedmont Valve Yard at Penitencia WTP) Purified pipeline (San José AWPF to Santa Clara [North of Hwy 101]) Pipeline easements	$190	$3.6
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$585	$22.3
ROC Management (existing outfall)	$20	$1.8
Total, with ROC Management	$605	$24.1

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

3.3 Portfolio 2 - Combined Regional Palo Alto/Sunnyvale AWPF

Portfolio 2 is centered around combining available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for treatment at one AWPF that would provide regional benefit through GWR at LGRP. Source flow availability is a key consideration for a Palo Alto and Sunnyvale-based portfolio. In contrast to previous projections, influent flows have remained generally consistent over the last five years (2014 through 2018). Assuming flows remain constant through the planning horizon, available flows are expected to yield around

17,300 AFY for PR. Should influent flows increase at the rate projected in previous wastewater and recycled water planning studies, a PR project could approach a yield of 23,000 AFY.

Sourcing one AWPF from two WWTPs (operated by two separate agencies) is not common and would likely involve unique interagency and regulatory circumstances. Any compliance or reporting requirements would be doubled (e.g., both agencies would have to demonstrate that their source control programs meet the requirements). In addition, the two WWTPs contributing flow to the AWPF would need to establish a clear plan and process to coordinate operations, monitoring, and maintenance, as well as execute institutional agreements to formalize roles and responsibilities.

3.3.1 Portfolio 2a – Combined Regional AWPF in Palo Alto for GWR (LGRP)

Portfolio 2a would deliver up to 23,000 AFY from an AWPF located at the former LATP site to LGRP for GWR (Figure 3-5). There are four possible purified water alignments, though the eastern route bypassing Sunnyvale (PL-7 and PL-11) was used for estimating the portfolio cost. The LATP site is relatively small and irregularly shaped, which limits the ability to provide full perimeter access around the AWPF. With these site limitations, treatment process expansions and additions would be limited in the future. For ROC Management, a pipeline would be needed to send ROC from the AWPF (located at the former LATP site) to the Palo Alto RWQCP outfall.

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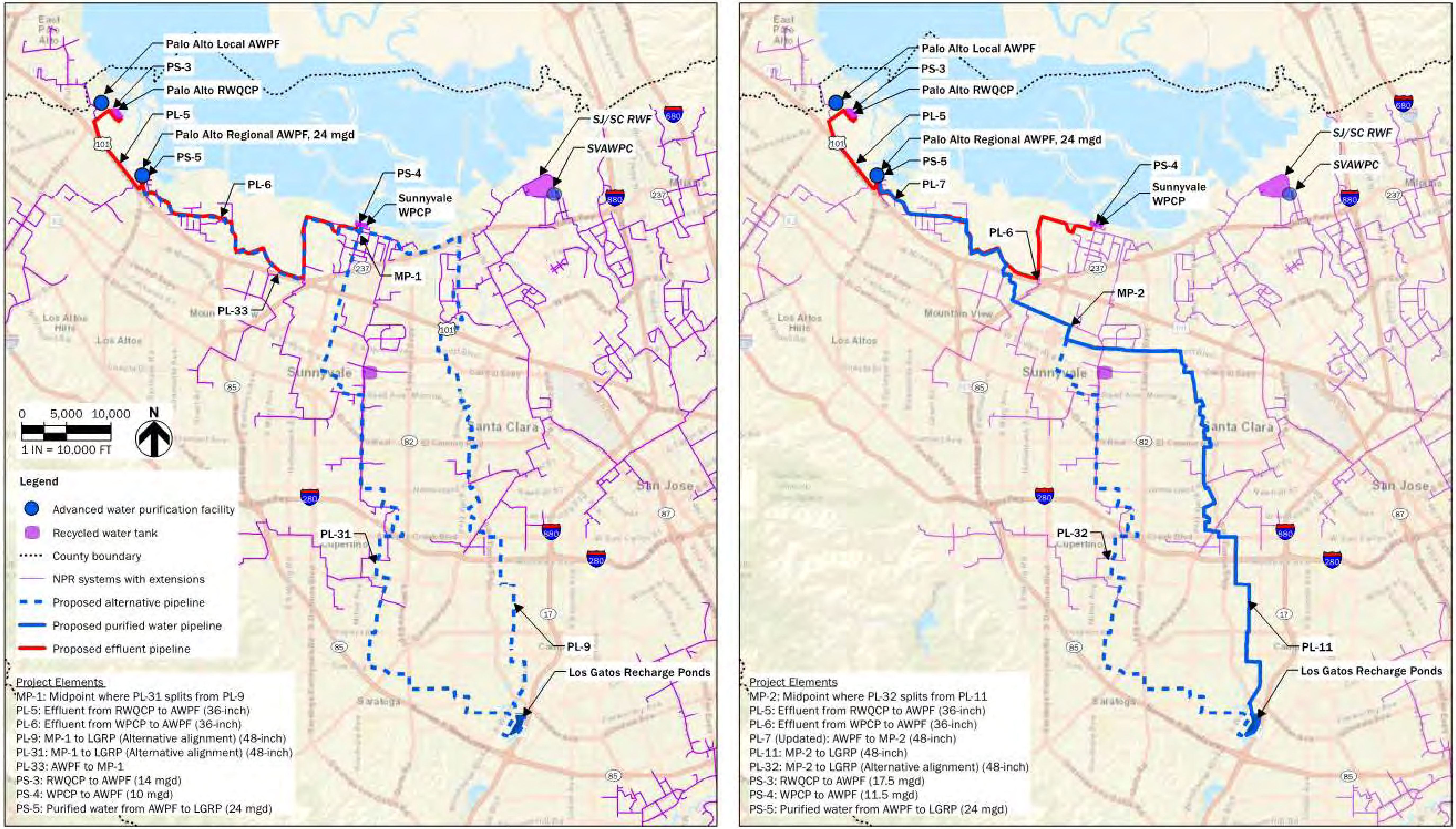

Legend
- ● Advanced water purification facility
- ■ Recycled water tank
- ····· County boundary
- — NPR systems with extensions
- - - Proposed alternative pipeline
- — Proposed purified water pipeline
- — Proposed effluent pipeline

Project Elements
MP-1: Midpoint where PL-31 splits from PL-9
PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-6: Effluent from WPCP to AWPF (36-inch)
PL-9: MP-1 to LGRP (Alternative alignment) (48-inch)
PL-31: MP-1 to LGRP (Alternative alignment) (48-inch)
PL-33: AWPF to MP-1
PS-3: RWQCP to AWPF (14 mgd)
PS-4: WPCP to AWPF (10 mgd)
PS-5: Purified water from AWPF to LGRP (24 mgd)

Project Elements
MP-2: Midpoint where PL-32 splits from PL-11
PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-6: Effluent from WPCP to AWPF (36-inch)
PL-7 (Updated): AWPF to MP-2 (48-inch)
PL-11: MP-2 to LGRP (48-inch)
PL-32: MP-2 to LGRP (Alternative alignment) (48-inch)
PS-3: RWQCP to AWPF (17.5 mgd)
PS-4: WPCP to AWPF (11.5 mgd)
PS-5: Purified water from AWPF to LGRP (24 mgd)

Figure 3-5. Portfolio 2a PR overview

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Table 3-9 summarizes Portfolio 2a facilities.

Table 3-9. Portfolio 2a Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Palo Alto	Capacity	24.5	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-3	Flow	12,000	gpm[a]	PA RWQCP to PA AWPF
	TDH	100	ft	
PS-4	Flow	8,000	gpm[a]	Sunnyvale WPCP to Palo Alto AWPF
	TDH	100	ft	
PS-5	Flow	16,700	gpm[a]	Delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP
	Length	2.9	miles	
PL-6	Diameter	36	in	Effluent from Sunnyvale WPCP
	Length	7.4	miles	
PL-7	Diameter	48	in	Purified water to LGRP
	Length	20.3	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018)
ROC management pipeline				
ROC management pipeline	Diameter	18	in	
	Length	10,900	ft	

a. 1 gpm = 0.00144 mgd

Table 3-10 contains estimated capital and annual O&M costs for Portfolio 2a elements, presented in 2019 dollars.

Table 3-10. Portfolio 2a Estimated Cost Summary[a]

Element	Capital Cost ($2019, in millions)	Annual O&M Cost ($2019, in millions)
AWPF (Palo Alto 24.5 mgd GWR)	$310	$13.6
Conveyance infrastructure Pump station (Palo Alto RWQCP effluent) Effluent pipeline (Palo Alto RWQCP to Palo Alto AWPF) Pump station (Sunnyvale WPCP effluent) Effluent pipeline (Sunnyvale WPCP to Palo Alto AWPF) Pump station (Palo Alto AWPF purified water) Purified pipeline (Palo Alto AWPF to LGRP) LGRP improvements Pipeline easements	$455	$5.0
Annual Potable Reuse Supply	--	$2.3
Total, without ROC Management	$765	$20.9
ROC Management (existing outfall)	$35	$1.6
Total, with ROC Management	$800	$22.5

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs..

3.3.2 Portfolio 2b – Sunnyvale AWPF Site for GWR (LGRP)

Portfolio 2b would deliver up to 23,000 AFY to LGRP for GWR from the AWPF located on Recycle Hill (Figure 3-6). Due to its history as a former landfill, Recycle Hill would need to be reclaimed to support locating the AWPF at this site. Refer to Appendix E-2 for the preliminary geotechnical study related to this site. Assumed costs for reclaiming Recycle Hill are based on recommendations from city of Sunnyvale staff and included in Portfolio 1b cost estimates. There are two possible routes to convey purified water from the Sunnyvale AWPF to LGRP, though the eastern route (PL-9) was selected to estimate the portfolio cost.

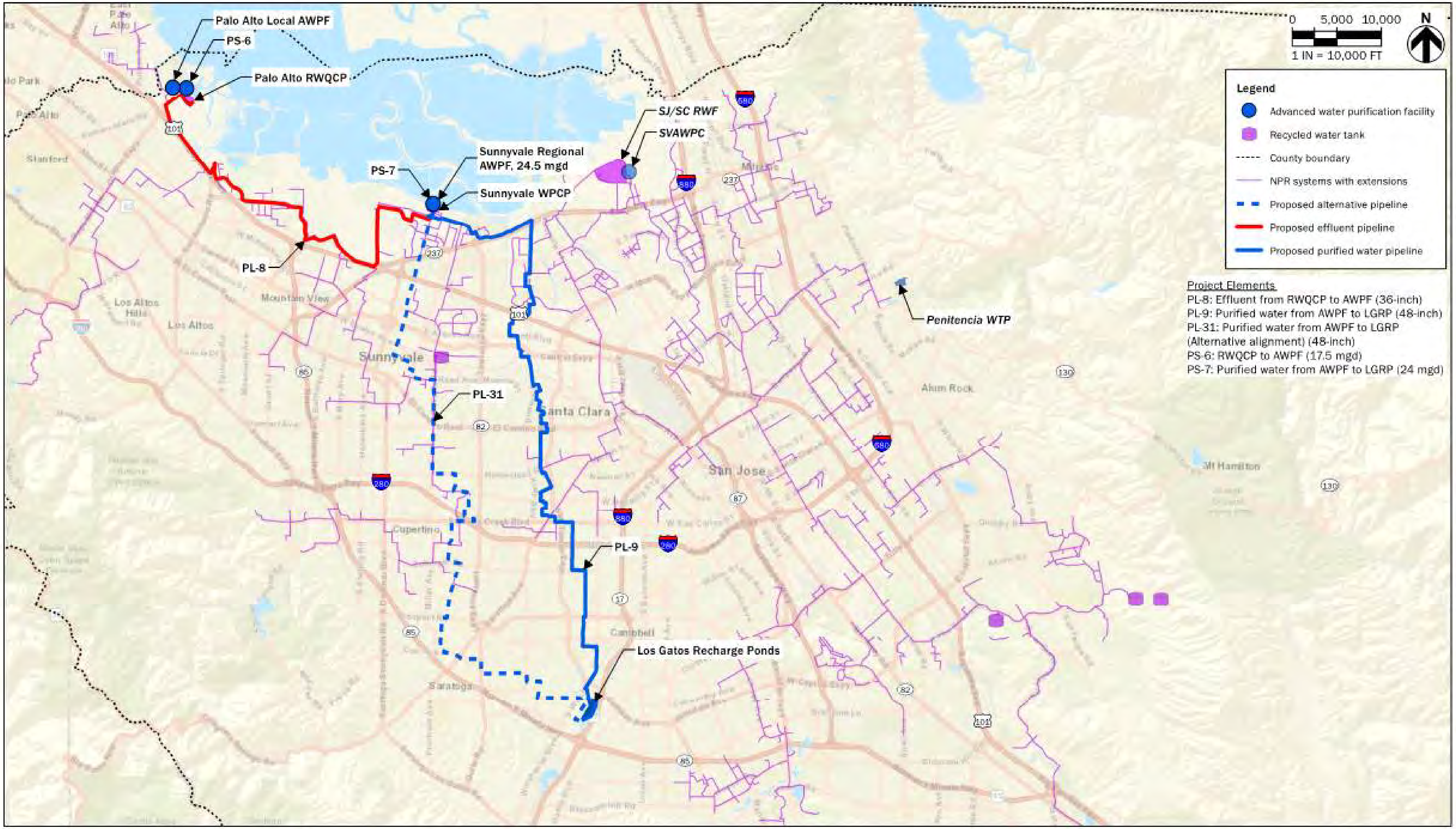
Palo Alto Local AWPF
PS-6
Palo Alto RWQCP
PS-7
Sunnyvale Regional AWPF, 24.5 mgd
Sunnyvale WPCP
SJ/SC RWF
SVAWPC
PL-8
PL-31
PL-9
Penitencia WTP
Los Gatos Recharge Ponds
Palo Alto
Stanford
Los Altos Hills
Los Altos
Mountain View
Sunnyvale
Santa Clara
Milpitas
San Jose
Cupertino
Campbell
Saratoga
Alum Rock
Mt Hamilton
0 5,000 10,000
1 IN = 10,000 FT
N
Legend
● Advanced water purification facility
● Recycled water tank
----- County boundary
NPR systems with extensions
Proposed alternative pipeline
Proposed effluent pipeline
Proposed purified water pipeline
Project Elements
PL-8: Effluent from RWQCP to AWPF (36-inch)
PL-9: Purified water from AWPF to LGRP (48-inch)
PL-31: Purified water from AWPF to LGRP (Alternative alignment) (48-inch)
PS-6: RWQCP to AWPF (17.5 mgd)
PS-7: Purified water from AWPF to LGRP (24 mgd)

Figure 3-6. Portfolio 2b PR overview

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Table 3-11 summarizes Portfolio 2b facilities.

Table 3-11. Portfolio 2b Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Sunnyvale	Capacity	24.5	mgd	24 mgd for potable reuse; 0.5 mgd for NPR+ in Sunnyvale
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-6	Flow	12,000	gpm[a]	Effluent from Palo Alto RWQCP to Sunnyvale AWPF
	TDH	100	ft	
PS-7	Flow	16,700	gpm[a]	Purified water delivery to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-8	Diameter	36	in	Effluent from Palo Alto RWQCP to Sunnyvale AWPF
	Length	10.0	miles	
PL-9	Diameter	48	in	
	Length	17.1	miles	
Delivery point improvements				
LGRP improvements	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018)
ROC management pipeline				
ROC management pipeline	Diameter	18	in	
	Length	32,800	ft	

a. 1 gpm = 0.00144 mgd

Table 3-12 contains estimated capital and annual O&M costs for Portfolio 2b elements, presented in 2019 dollars.

Table 3-12. Portfolio 2b Estimated Cost Summary

Element	Estimated Capital Cost ($2019, in millions)	Estimated O&M Costs ($2019, in millions)
AWPF (Sunnyvale 24.5 mgd GWR)	$360	$13.6
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Effluent pipeline (Palo Alto RWQCP to Sunnyvale AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to LGRP) LGRP improvements Pipeline easements	$405	$4.1
Annual Potable Reuse Supply	--	$2.3
Total, without ROC Management	$765	$20.0
ROC Management (new outfall with enhanced mixing)	$40	$1.6
Total, with ROC Management	$805	$21.6

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

3.4 Portfolio 4 – Separate Palo Alto and Sunnyvale AWPFs for GWR

Portfolio 4 is centered on using available effluent from the Palo Alto RWQCP and the Sunnyvale WPCP for GWR at the LGRP. In this portfolio, two AWPFs would be constructed to use the available flow from each WWTP (Figure 3-7). The Sunnyvale AWPF would be located on Recycle Hill, and the Palo Alto facility would be on the former LATP site located in Palo Alto. Appendix A-4 includes layouts for these facilities. Corresponding project elements include effluent conveyance pipelines, purified water conveyance pipeline from the AWPF to LGRP, infrastructure improvements to integrate purified water into LGRP, and ROC Management infrastructure. There are two possible routes to convey purified water from the mid-point (Joint Purified Water Pipeline) to LGRP, though the eastern route (PL-11) was selected to estimate the portfolio cost.

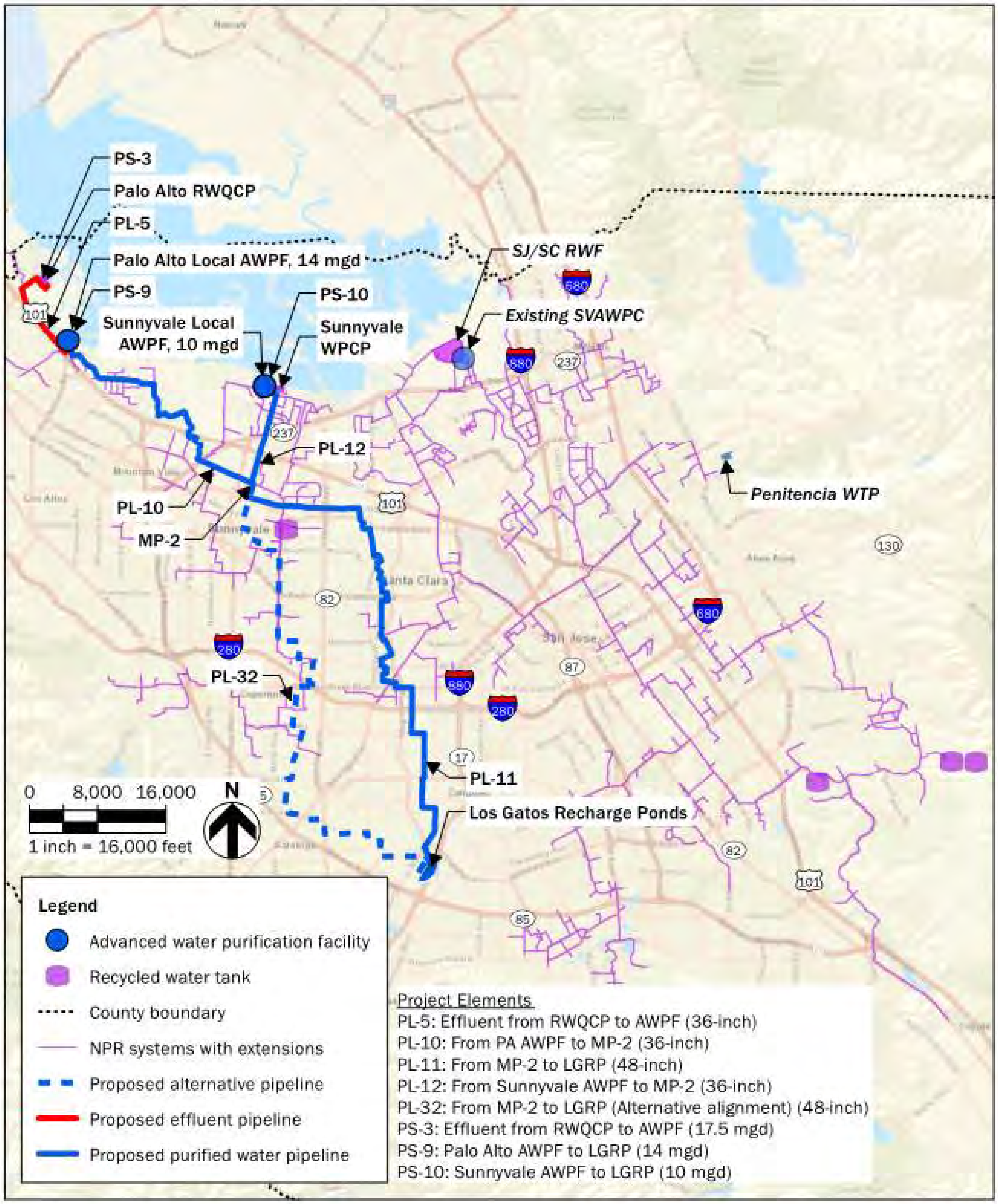

PS-3
Palo Alto RWQCP
PL-5
Palo Alto Local AWPF, 14 mgd
PS-9
Sunnyvale Local AWPF, 10 mgd
PS-10
Sunnyvale WPCP
SJ/SC RWF
Existing SVAWPC
PL-12
Penitencia WTP
PL-10
MP-2
PL-32
PL-11
Los Gatos Recharge Ponds
0 8,000 16,000
1 inch = 16,000 feet
N
Legend
Advanced water purification facility
Recycled water tank
County boundary
NPR systems with extensions
Proposed alternative pipeline
Proposed effluent pipeline
Proposed purified water pipeline
Project Elements
PL-5: Effluent from RWQCP to AWPF (36-inch)
PL-10: From PA AWPF to MP-2 (36-inch)
PL-11: From MP-2 to LGRP (48-inch)
PL-12: From Sunnyvale AWPF to MP-2 (36-inch)
PL-32: From MP-2 to LGRP (Alternative alignment) (48-inch)
PS-3: Effluent from RWQCP to AWPF (17.5 mgd)
PS-9: Palo Alto AWPF to LGRP (14 mgd)
PS-10: Sunnyvale AWPF to LGRP (10 mgd)

Figure 3-7. Portfolio 4 PR overview

Available flow is a key characteristic of a Palo Alto and Sunnyvale-based portfolio. Over the last five years, influent flows have remained generally constant rather than increasing as previously projected. Similar to Portfolio 2, currently available flows would only support approximately 17,300 AFY in PR. Should influent flows increase at rates projected in prior wastewater and recycled water planning studies, a PR project could approach 23,000 AFY in the 2040 timeframe.

Table 3-13 summarizes key Portfolio 4 facilities criteria.

Table 3-13. Portfolio 4 Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Separate regional AWPF (1 of 2) in Palo Alto	Capacity	14	mgd	14 mgd for potable reuse
Separate regional AWPF (2 of 2) in Sunnyvale	Capacity	10.5	mgd	10 mgd for potable reuse; 0.5 mgd for NPR+
Annual yield				
Annual yield	Upper bound	23,000	AFY	Assuming upper bound of future WWTP influent flows
	Lower bound	17,000	AFY	Assuming lower bound of future WWTP influent flows. Under these flow conditions, only an 18-mgd facility would be constructed.
Pump stations				
PS-3	Flow	12,000	gpm[a]	Effluent from Palo Alto RWQCP to Palo Alto AWPF
	TDH	100	ft	
PS-9	Flow	9,720	gpm[a]	Purified water from Palo Alto Separate AWPF to LGRP
	TDH	400	ft	
PS-10	Flow	6,950	gpm[a]	Purified water from Sunnyvale AWPF to LGRP
	TDH	400	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP to Palo Alto AWPF
	Length	2.9	mi	
PL-10	Diameter	36	in	Purified water from Palo Alto AWPF to mid-point (Joint Purified Water Pipeline)
	Length	6.5	mi	
PL-11	Diameter	48		Purified water from Joint Purified Water Pipeline (at Arques) to LGRP
	Length	13.7		
PL-12	Diameter	36	in	Purified water from Sunnyvale to mid-point (Joint Purified Water Pipeline)
	Length	2.2	mi	
Delivery point improvements				
LGRP improvements [a]	n/a	n/a	n/a	The existing LGRP would require various infrastructure improvements (new pipes, monitoring equipment, etc.) to accept purified water (Valley Water, 2018)
ROC management pipeline				
ROC management pipeline for Palo Alto	Diameter	14	in	
	Length	10,900	ft	
ROC management pipeline for Sunnyvale	Diameter	12	in	
	Length	32,800	ft	

a. 1 gpm = 0.00144 mgd

Table 3-14 contains estimated capital and annual O&M costs for Portfolio 4 elements, presented in 2019 dollars.

Table 3-14. Portfolio 4 Estimated Cost Summary

Element	Estimated Cost ($2019, in millions)	
	Capital	Annual O&M
AWPF (Palo Alto 14-mgd GWR)	$205	$8.5
AWPF (Sunnyvale 10.5-mgd GWR)	$220	$6.4
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Effluent pipeline (Palo Alto RWQCP to Palo Alto AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to Joint Purified Water Pipeline) Pump station (Palo Alto AWPF, purified water) Purified pipeline (Palo Alto AWPF to Joint Purified Water Pipeline) LGRP improvements Pipeline easements	$380	$4.1
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$805	$21.4
ROC Management (new outfall with enhanced mixing)	$45	$1.6
Total, with ROC Management	$850	$23.0

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

3.5 South County Reuse Options

To explore solutions to augment Morgan Hill's overall supply, the Project Team reviewed previous South County reuse work and developed new conceptual alternatives for consideration.

The 2015 South County RWMP Update, used as the primary reference source, evaluated water reuse alternatives for South County, including supplying recycled water from the SCRWA WWTP to Morgan Hill—an option determined to require a new transmission main of about 10 miles and substantial energy to convey water north from an elevation of about 155 feet at SCRWA to Morgan Hill-area customers at elevations between 345 to 400 feet.

The 2015 South County RWMP identified a preferred option involving expanding NPR near the SCRWA plant and the existing recycled water distribution system in Gilroy. However, as the plan acknowledged, the SCRWA facility is challenged in meeting existing maximum day NPR demand (5.2 mgd in 2014) and reuses most of the average dry weather influent flow (6.0 mgd in 2014).

Morgan Hill has indicated a desire to be supplied recycled water consistent with Options MH-6 and MH-7 as described in the 2015 South County RWMP, which would serve 36 customers including schools, parks, and the Institute Golf Course (Figure 3-8).

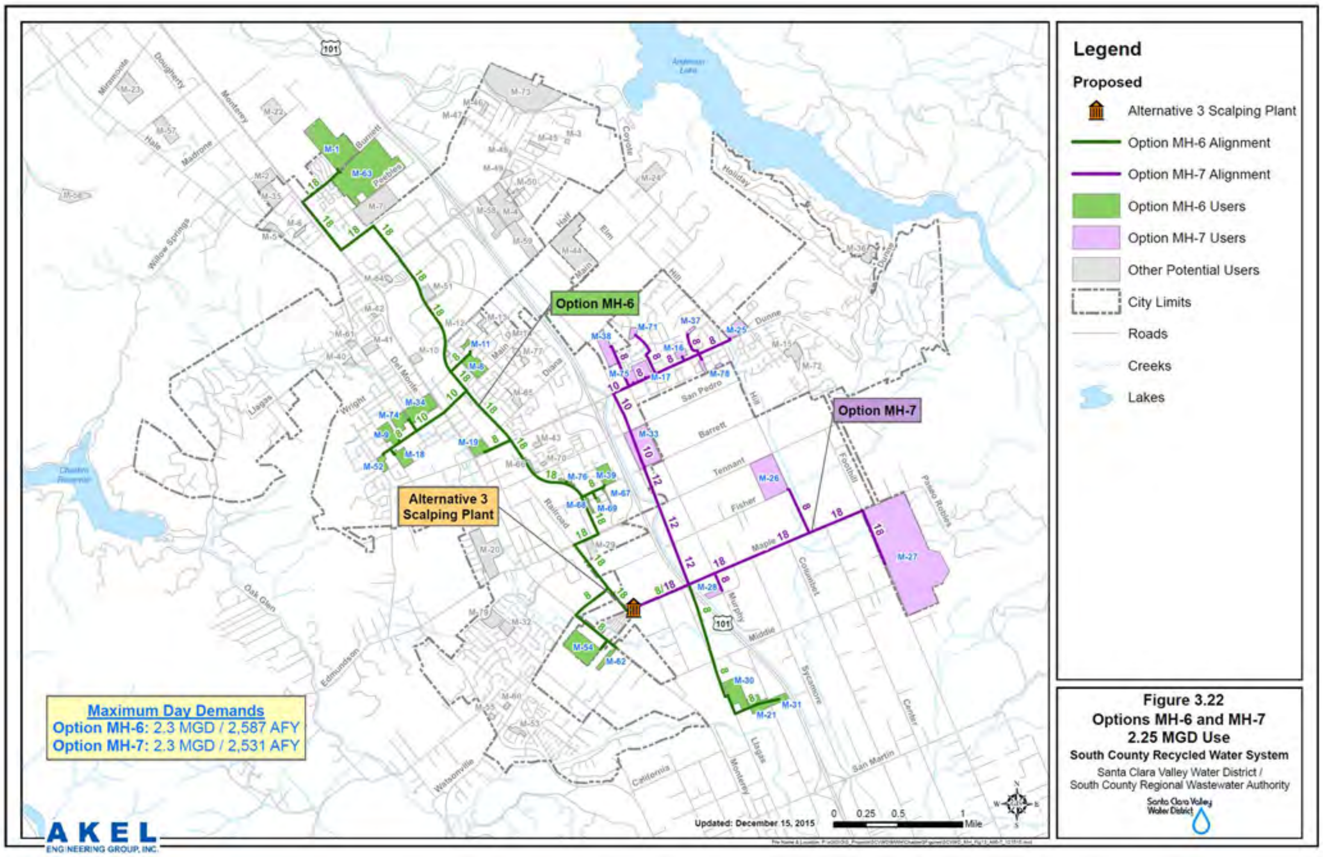

Legend
Proposed
Alternative 3 Scalping Plant
Option MH-6 Alignment
Option MH-7 Alignment
Option MH-6 Users
Option MH-7 Users
Other Potential Users
City Limits
Roads
Creeks
Lakes
Option MH-6
Option MH-7
Alternative 3 Scalping Plant
Maximum Day Demands
Option MH-6: 2.3 MGD / 2,587 AFY
Option MH-7: 2.3 MGD / 2,531 AFY
Figure 3.22
Options MH-6 and MH-7
2.25 MGD Use
South County Recycled Water System
Santa Clara Valley Water District / South County Regional Wastewater Authority
Updated: December 15, 2015
0 0.25 0.5 1 Mile
AKEL ENGINEERING GROUP, INC.

Figure 3-8. Morgan Hill potential NPR distribution system

Source: SCRWA, 2016. (2015 South County Recycled Water Master Plan Update)

The Countywide Master Plan is exploring several new project concepts. A new NPR+ concept would involve service from the SBWR system using a new 16-inch pipeline extension. The pipeline would be located on Monterey Road beginning at the current SBWR terminus near Blanchard Road and Metcalf Energy Center (elevation of 255 feet) and continuing about 6 miles to Burnett Road in Morgan Hill (Figure 3-9). At Burnett Road, the pipeline extension from SBWR would connect into the northern terminus of the Morgan Hill NPR distribution system (MH-6 alignment as presented in the 2015 South County RWMP Update). Morgan Hill's distribution network is estimated at 16.3 miles of pipelines with elevations ranging between approximately 345 to 400 feet. The transmission line could serve peak demands of up to 5 mgd to Morgan Hill, meeting an annualized NPR demand of 2,900 AFY.

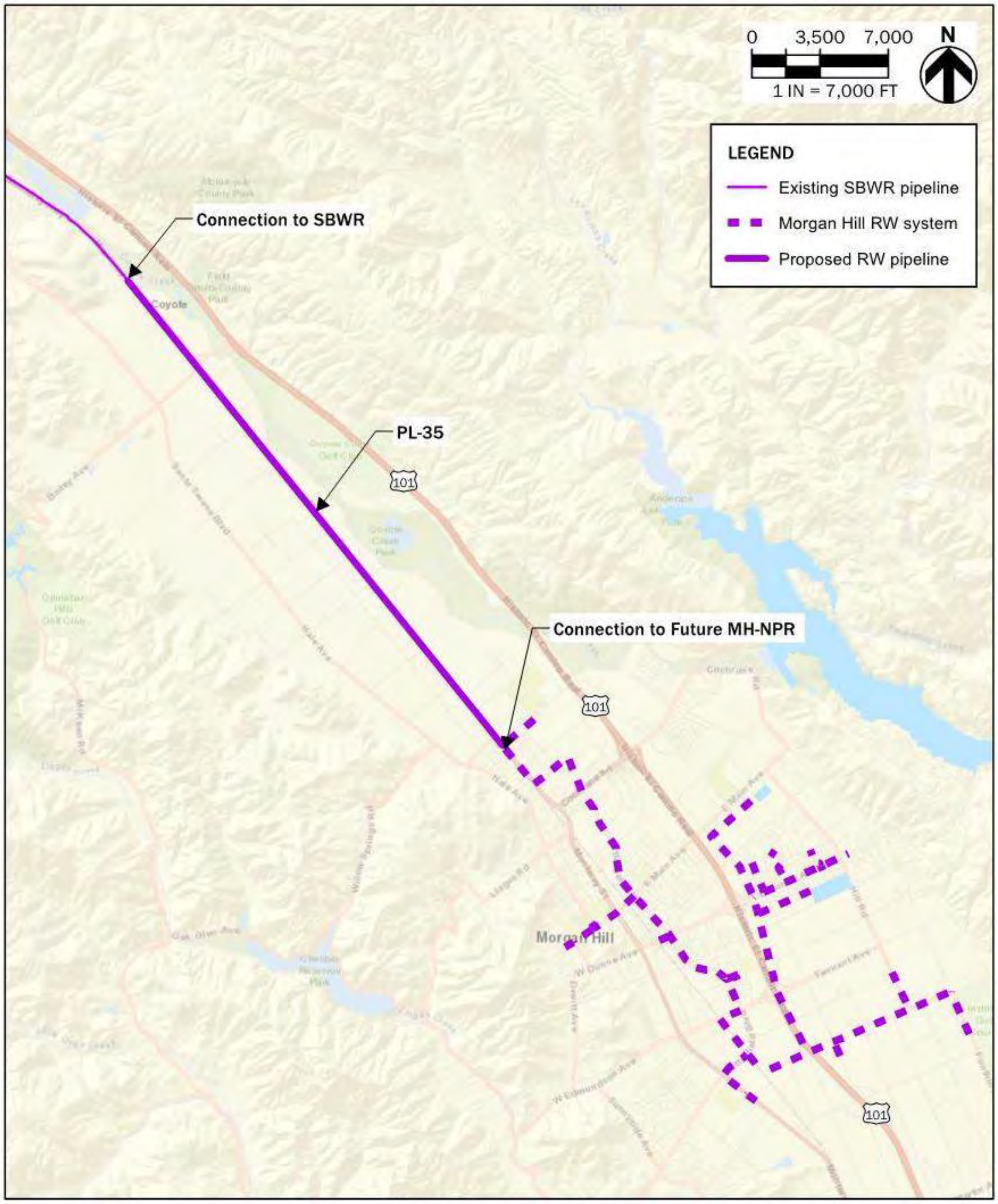


Figure 3-9. Transmission line from SBWR to Morgan Hill for NPR+ distribution

Source for Morgan Hill NPR distribution system: SCRWA (2016)

In addition, two conceptual IPR alternatives were evaluated—GWR and SWA from a satellite WWTF, and AWPF. Locations for both the satellite treatment facility and recharge ponds are challenges that have kept these options conceptual in nature. For the purpose of preliminary design and cost assessments, the GWR alternative assumes the treatment facility would be located at the site identified for a satellite treatment plant in the 2014 South County RWMP, and a transmission pipeline would convey purified water to the existing San Pedro recharge ponds as the delivery point (Figure 3-10). Due to the significant number of potable wells in the service area, travel time in the groundwater basin is assumed to be two months for planning purposes.

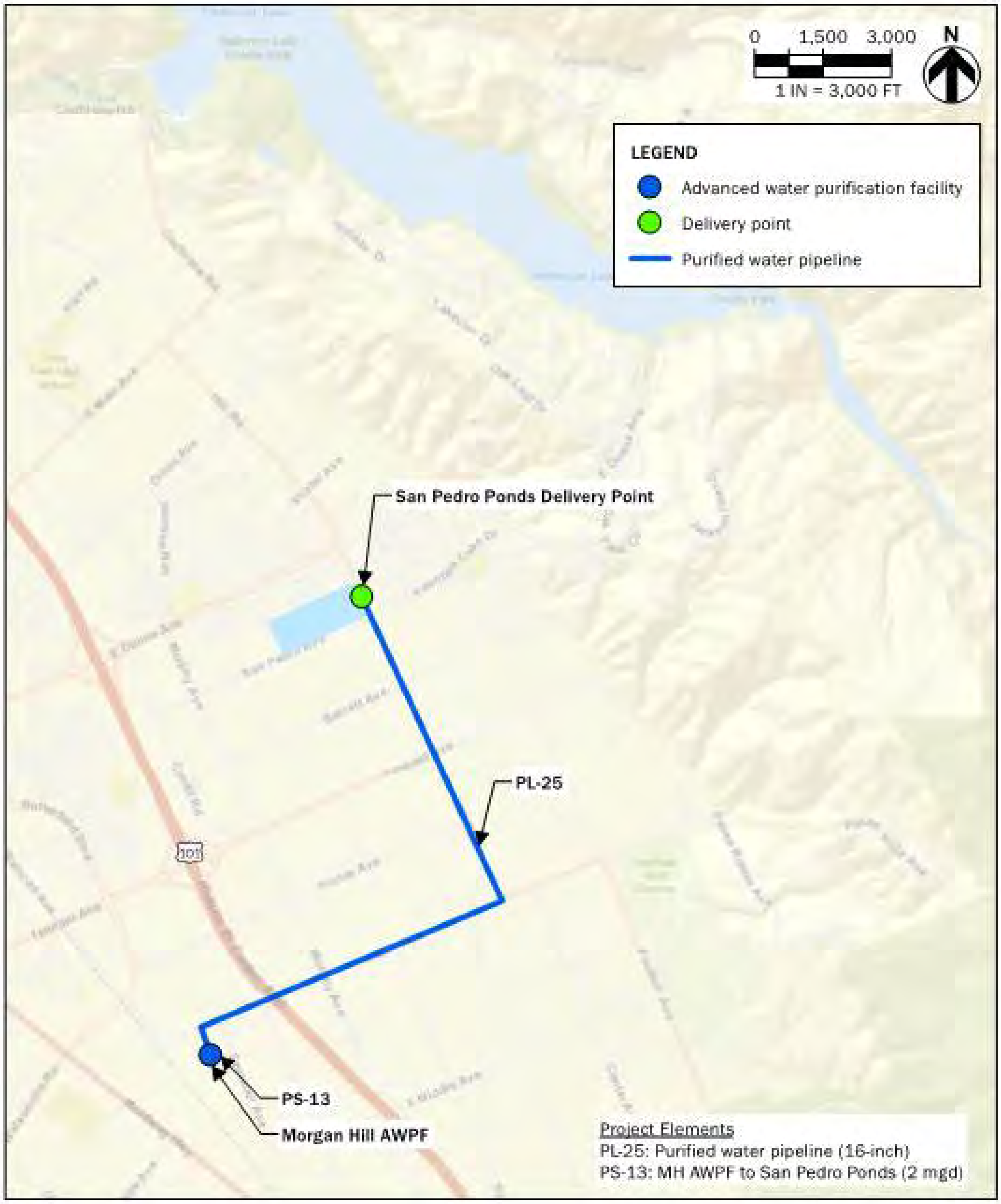

0 1,500 3,000
1 IN = 3,000 FT
N
LEGEND
Advanced water purification facility
Delivery point
Purified water pipeline
San Pedro Ponds Delivery Point
PL-25
PS-13
Morgan Hill AWPF
Project Elements
PL-25: Purified water pipeline (16-inch)
PS-13: MH AWPF to San Pedro Ponds (2 mgd)

Figure 3-10. Transmission line from proposed Morgan Hill AWPF to San Pedro Recharge Ponds

Note: The San Pedro Ponds delivery point is assumed for preliminary design; further evaluation is needed to determine feasibility.

The SWA variation assumes a transmission pipeline would convey purified water from the AWPF to the south end of Anderson Reservoir (Figure 3-11). Using an assumed alignment on East Duane Avenue, the pipeline would traverse up to an elevation (ground) of approximately 880 feet, which would result in a static lift of about 560 feet. While a detailed analysis has not been performed as part of this conceptual evaluation, dilution and detention time are assumed to be significant for a 2.1-mgd SWA project, considering Anderson's total capacity of more than 89,000 AF. Consistent with current operations, Valley Water will treat the blended supply from Anderson Reservoir at Santa Teresa WTP or Rinconada WTP. Thus, purified water supplied to Anderson Reservoir would generally be used north of Morgan Hill. In exchange for contributing supply to Anderson Reservoir, Valley Water would increase deliveries from the Santa Clara Conduit to existing percolation ponds to recharge the Llagas Subbasin. The San Pedro Ponds is the assumed recharge location for preliminary design. Further evaluation is needed to determine feasibility of this location and to compare it to other possible sites.

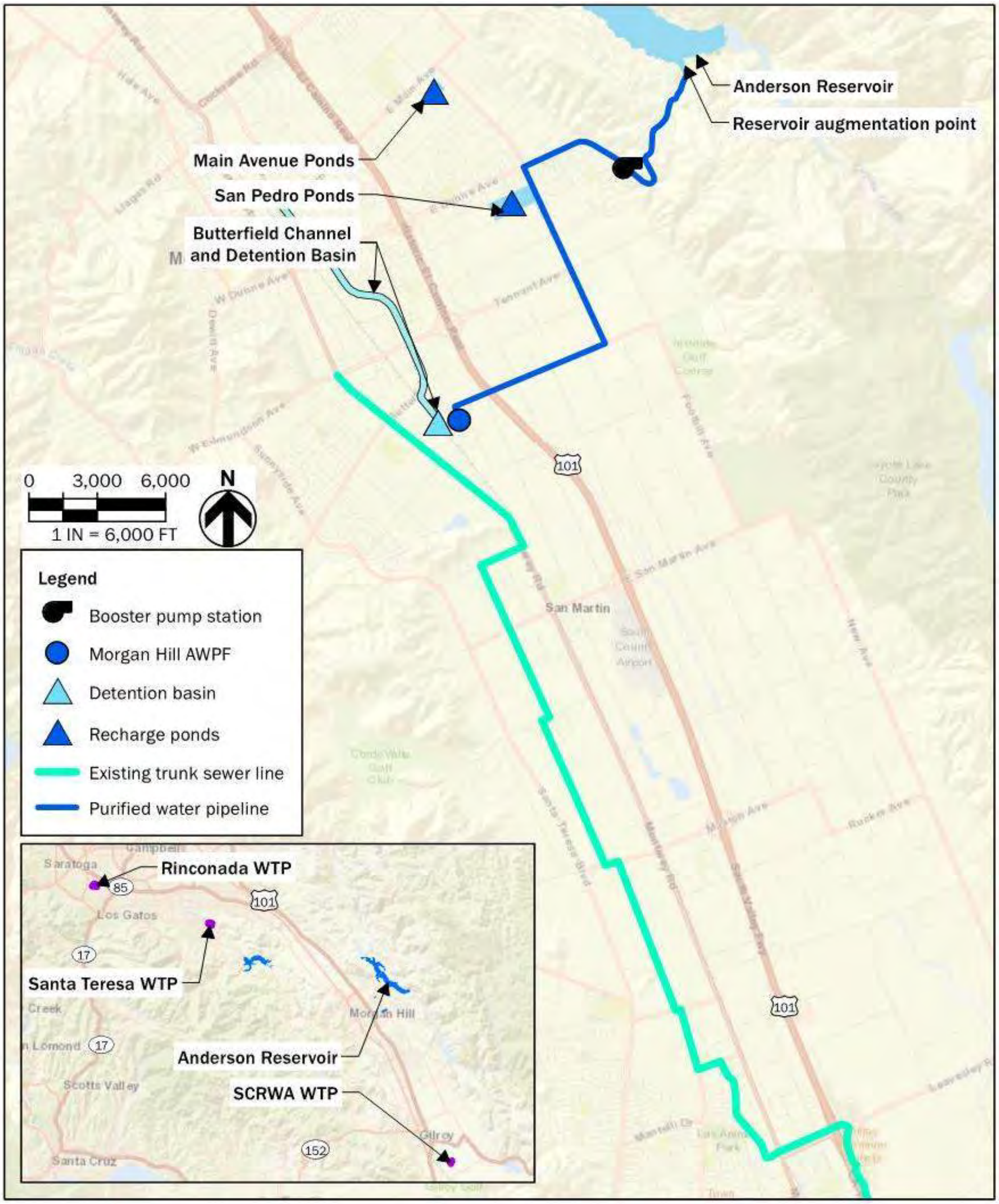


Figure 3-11. Transmission line from proposed Morgan Hill AWPF to Anderson Reservoir

For the IPR alternatives, a FAT train is assumed and requires a ROC Management solution. Valley Water's ROCMP team reports that the Morgan Hill AWPF would require 80 to 100 acres of lined evaporation ponds as the best option for managing ROC. Due to limited land availability in Morgan Hill, ponds are assumed to be located near the SCRWA facility in Gilroy and would require construction of a 59,000 ft, 8-inch pipeline to convey ROC from the Morgan Hill AWPF to Gilroy.

A challenge with Morgan Hill IPR is that diverting flow from the trunk sewer reduces flow at the SCRWA plant, which currently uses much of the available effluent for NPR in Gilroy, particularly during the summer months. In addition, the SCRWA partners, including Morgan Hill, have recently decided to move forward with expanding the SCRWA treatment plant for future wastewater treatment. Should a satellite WWTP facility also be developed, the region may end up with underutilized assets (i.e., unused WWTP capacity) and other unanticipated collection system issues due to reduced wastewater flows.

Table 3-15 summarizes the Morgan Hill alternatives considered.

Table 3-15. Morgan Hill Alternatives Comparison Summary

Item	Reference point: NPR from SCRWA [a]	Option 1: NPR+ from SBWR [b,c]	Option 2: Satellite AWPF for GWR	Option 3: Satellite AWPF for SWA
Annual yield (AFY)	785	2,900	2,350	2,350
Transmission pipeline length (miles)	9.0	6.0	2.8	5.9
NPR distribution pipelines length (miles)	9.6	16.3	--	--
Max elevation gain along pipelines (feet)	190 to 245	90 to 145	~48	~560
Capital ($2019 in millions)				
Treatment	--	--	$60	$60
Conveyance infrastructure, including pipeline easements	$40	$30	$15	$35
NPR distribution infrastructure	$20	$40	--	--
ROC management	--	--	$50[d]	$50[d]
Well relocation (~31 wells)	--	--	TBD	--
Total capital cost	$60	$70	$125	$145
Annual O&M ($2019 in millions)				
Treatment	--	--	$6.6	$6.6
Transmission infrastructure	$1.2	$0.1	$0.2	$0.5
NPR distribution infrastructure	$0.7	$0.7	--	--
Source water cost	--	$1.8 [c]	--	--
ROC management	--	--	$0.1	$0.1
Total O&M cost	$1.9	$2.6	$6.9	$7.2

a. *Based on costs presented in the 2015 South County RWMP Update.*

b. *Long-term recycled water supply from the SBWR system would require an institutional agreement with the City of San José. In addition, numerous opportunities for recycled water expansion in the north portion of the County may limit recycled water availability. Annual yield is based on Morgan Hill's conceptual buildout demand from the 2015 South County Recycled Water Master Plan Update, assuming sufficient NPR supply from SBWR to meet demand.*

c. *Assuming $600/AF.*

d. *Estimated ROC management cost does not include the cost of land for evaporation ponds. All ROC management costs are subject to change.*

Before implementing any of the South County reuse options, the following issues need to be reviewed and confirmed:

- **Appropriate sizing to avoid impacts to the sewage collection system during times of minimum flows.** Solids resulting from MBR treatment at a Morgan Hill satellite WWTP are assumed to discharge into the trunk line for treatment at SCRWA's WWTP. Further design consideration is needed to avoid potential creation of odor and clogging problems in the existing collection system.
- **Process performance issues at the SCRWA WWTP due to influent composition changes.** Decreased flow from Morgan Hill with more concentrated solids content would create operational and process performance issues at the WWTP with inconsistent sludge wasting and reduced BOD loadings. WWTP improvements to address these potential issues are currently not included in the costs presented in the Countywide Master Plan and would need to be considered and confirmed before implementing this project.
- **Ability to meet current South County RWS demands for recycled water.** Reduced inflows to SCRWA's WWTP could result in the inability to meeting current recycled water demands at times of critical and peak demand.

3.6 Future Opportunities and Alternative Elements

Several potential project elements discussed in Section 2 are not considered baseline components of any portfolio but may be included through either a substitution (e.g., an alternate pipeline alignment) or "add-on" (e.g., new interties between systems). These alternative project elements are summarized below.

3.6.1 Potential Future NPR Projects

AWPF for NPR+ in Sunnyvale. Sunnyvale does not have a need for NPR+ in its service area; however, if there is reason to connect to either PA/MV and/or SBWR NPR+ systems, Sunnyvale may consider an AWPF to provide water quality consistent with SBWR and PA/MV systems.

Additional AWPF in San José for NPR+. Sometimes referred to as an "SVAWPC extension," an additional AWPF may be considered in San José to increase purified water production capacity for NPR+ to maintain a TDS level of 500 mg/L year-round.

3.6.2 System Interties

The following interties were considered as project elements but not included in any portfolio. One or more interties may be added later if a need arises.

Sunnyvale-SBWR interties. Three interties between Sunnyvale and SBWR were considered, including an effluent intertie to convey secondary effluent from Sunnyvale WPCP to the SJ/SC RWF or SVAWPC and two recycled water interties (one northern and one southern connector).

Sunnyvale-PA/MV intertie. An intertie could connect an existing 16-inch pipeline on Enterprise Way in Sunnyvale to a new 16-inch recycled water pipeline located in Moffett Field.

Connecting Sunnyvale's recycled water distribution system to the SBWR or PA/MV system would require an AWPF for NPR+ in Sunnyvale for equivalent water quality.

3.6.3 Alternative PR Alignments

Multiple route variations were considered for conveying purified water from a new AWPF in Palo Alto and/or Sunnyvale to LGRP for GWR. One default alignment was selected for the purpose of determining costs and relative pipe lengths across portfolios, though other alignments also offer potential advantages. For example, the default alignment for Portfolio 2a (PL-7 and PL-11) is the shortest alignment and bypasses Sunnyvale. If, however, there is potential to also convey water to LGRP from a San José AWPF in the future, using the Expedited Purified Water Program alignment (PL-9) may be advantageous due its proximity to the SJ/SC RWF.

Table 3-16 summarizes the default and alternative pipeline alignments for Portfolios 2a, 2b, and 4, and includes relative capital costs. More detailed costs are presented in Appendix 6.

Table 3-16. Summary of Purified Water Pipeline Alignments by Portfolio

	Default Alignment			Alternate Alignment(s)		
Portfolio(s)	Pipeline Number	Description	Capital cost ($2019, in millions)	Pipeline Number	Description	Capital Cost ($2019, in millions)
Portfolio 2a Combined Regional AWPF in Palo Alto for GWR	PL-7	Eastern route (bypassing Sunnyvale) Palo Alto AWPF to LGRP	$295	PL-33 & PL-9	Eastern route, via Sunnyvale WPCP	$330
				PL-33 & PL-31	Western route, via Sunnyvale WPCP	$330
				PL – 32 (second portion of PL-7)	Western route, bypassing Sunnyvale (from MP-2 to LGRP)	$200
Portfolio 2b Sunnyvale AWPF Site for GWR	PL-9	Eastern route, Sunnyvale AWPF to LGRP	$250	PL-31	Western route, Sunnyvale AWPF to LGRP	$250
Portfolio 4 Separate Palo Alto and Sunnyvale AWPFs for GWR	PL-10	From Palo Alto AWPF to Joint Purified Water Pipeline	$70	Alternative not developed		
	PL-12	From Sunnyvale AWPF to Joint Purified Water Pipeline	$25	Alternative not developed		
	PL-11	Eastern route from Joint Purified Water Pipeline (with Sunnyvale AWPF product water) to LGRP	$200	PL-32	Western route from Joint Purified Water Pipeline to LGRP	$210

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

3.6.4 Potential Future PR Projects

Pipeline extension from LGRP to Rinconada WTP for RWA. As discussed in Section 2.1.2.4, there is potential to build a new pipeline and pump station from LGRP to Rinconada WTP to increase operational flexibility of options involving GWR. This RWA variation would improve potable reuse supply yield at times when the groundwater basin is filled at capacity and recharge is not possible. Preliminary estimates indicate capital costs for the pipeline would be approximately $25 million, with $20,000 in annual O&M costs.

West County TWA. Portfolios 1c and 1d explore using SJ/SC RWF source water for TWA because that allows for a case study that presents the full range of potable reuse options. However, there are opportunities for TWA throughout the county, including one that Valley Water is already considering and involves extending the West Pipeline. The West County TWA Scenario would deliver up to 24,000 AFY of purified water. Like Portfolio 2a, effluent would be conveyed from the PA RWQCP and Sunnyvale WPCP to a 24-mgd AWPF that would be constructed at the former Los Altos WWTP site.

From the AWPF, a pump station sized to convey 24 mgd at a TDH of ~500 ft would pump purified water from the PA AWPF to the West Pipeline. Local turnouts from this pipeline would be constructed to use purified water locally in Palo Alto and Mountain View during years where supplemental water supplies are required. The remainder of the purified water would be transported through the West Pipeline, where it would be blended with treated water and delivered through existing turnouts to customers along that pipeline.

Conveyance from the AWPF to the West Pipeline at Stevens Creek Blvd would require an 11 mile, 36-inch pipeline (shown in Figure 3-12). The pipeline route was selected to minimize traffic impacts, minimize easement requirement, and facilitate construction. Specifically, the route avoids longitudinal encroachments along both El Camino Real and Foothill Expressway, and is located to facilitate trenchless crossings of both Highway 101 and Interstate 280. Both the base and alternate alignments cross Interstate 280, but the base alignment is located under high voltage electrical transmission towers.

Table 3-17 summarizes the West County TWA scenario facilities. Table 3-18 contains estimated capital and annual O&M costs for the West County TWA scenario elements, presented in 2019 dollars.

Table 3-17. West County TWA Scenario Facilities Summary

Element	Criteria	Quantity	Unit	Notes
Combined regional AWPF in Palo Alto	Capacity	24	mgd	24 mgd for potable reuse
Annual yield				
Annual yield	Upper bound	17,300	AFY	Under current flows, only an 18-mgd facility would be implemented
	Lower bound	23,000	AFY	
Pump stations				
PS-3	Flow	12,000	gpm[a]	Effluent from PA RWQCP to Sunnyvale AWPF
	TDH	100	ft	
PS-4	Flow	8,000	gpm[a]	Effluent from Sunnyvale WPCP to Sunnyvale AWPF
	TDH	100	ft	
PS-18	Flow	16,700	gpm[a]	Delivery of treated water to West Pipeline at Stevens Creek Blvd
	TDH	500	ft	
Effluent and conveyance pipelines				
PL-5	Diameter	36	in	Effluent from Palo Alto RWQCP
	Length	2.9	miles	
PL-6	Diameter	36	in	Effluent from Sunnyvale WPCP
	Length	7.4	miles	
PL-44	Diameter	36	in	Purified water to West Pipeline at Stevens Creek Blvd
	Length	10.7	miles	
ROC Management pipeline				
ROC Management pipeline	Diameter	18	in	
	Length	10,900	ft	

a. 1 gpm = 0.00144 mgd

Table 3-18. West County TWA Scenario Estimated Cost Summary		
	Estimated Cost ($2019, in millions)	
Element	Capital	Annual O&M
AWPF (Palo Alto 24 mgd for TWA)	$380	$16.2
Conveyance infrastructure Pump station (Palo Alto RWQCP, effluent) Pump station (Sunnyvale WPCP, effluent) Effluent pipeline (Palo Alto RWQCP to Sunnyvale AWPF) Effluent pipeline (Sunnyvale WPCP to Sunnyvale AWPF) Pump station (Sunnyvale AWPF, purified water) Purified pipeline (Sunnyvale AWPF to West Pipeline) Pipeline easements	$255	$4.9
Annual Potable Reuse Supply	--	$2.4
Total, without ROC Management	$635	$23.5
ROC Management (existing outfall)	$35	$1.6
Total, with ROC Management	$670	$25.1

Values are rounded up to the nearest $5 million for capital costs and $100,000 for annual O&M costs.

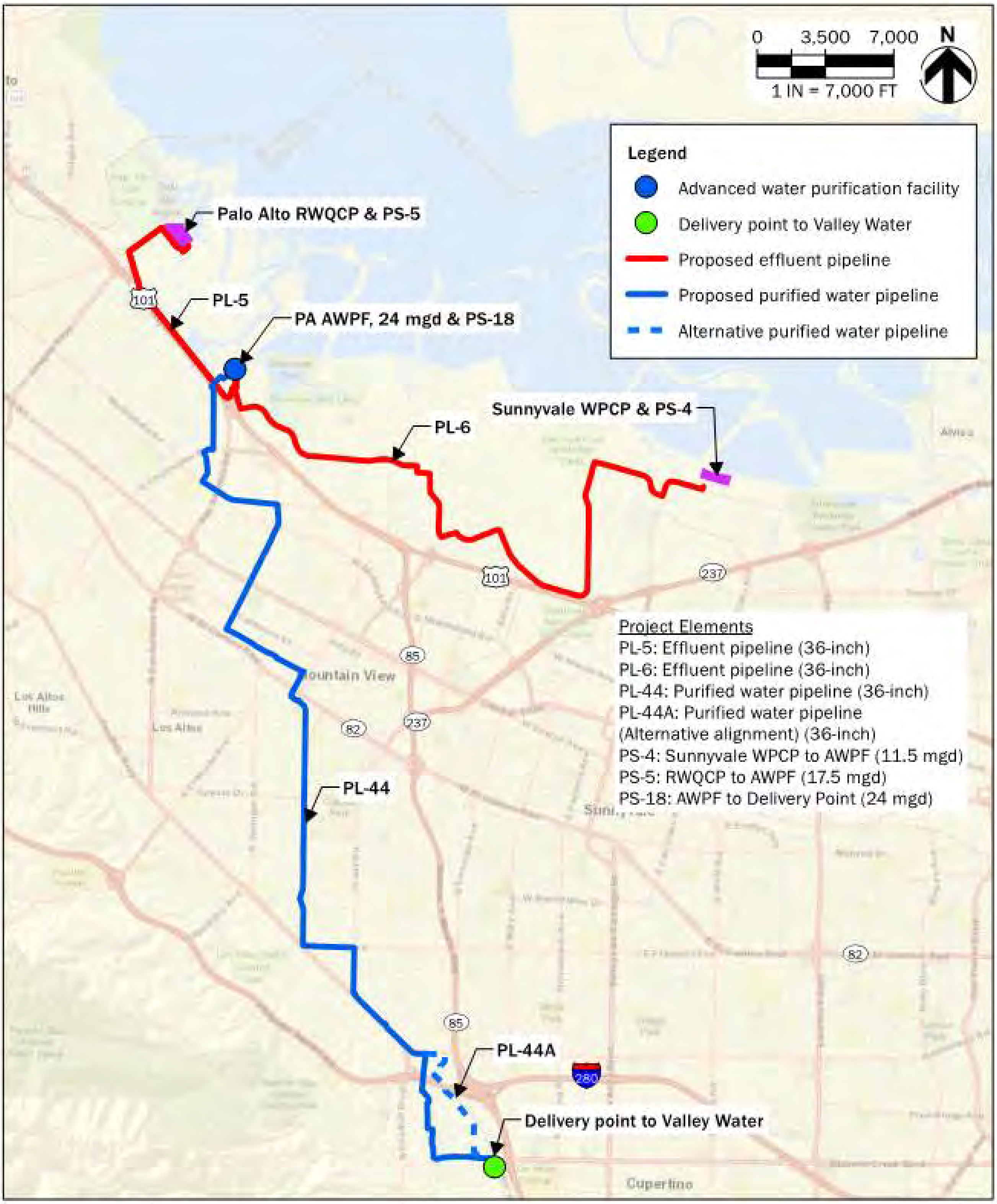

0
3,500
7,000
1 IN = 7,000 FT
N
Legend
● Advanced water purification facility
● Delivery point to Valley Water
Proposed effluent pipeline
Proposed purified water pipeline
Alternative purified water pipeline
Palo Alto RWQCP & PS-5
PL-5
PA AWPF, 24 mgd & PS-18
PL-6
Sunnyvale WPCP & PS-4
Project Elements
PL-5: Effluent pipeline (36-inch)
PL-6: Effluent pipeline (36-inch)
PL-44: Purified water pipeline (36-inch)
PL-44A: Purified water pipeline
(Alternative alignment) (36-inch)
PS-4: Sunnyvale WPCP to AWPF (11.5 mgd)
PS-5: RWQCP to AWPF (17.5 mgd)
PS-18: AWPF to Delivery Point (24 mgd)
PL-44
PL-44A
Delivery point to Valley Water
101
237
85
82
280
Mountain View
Los Altos
Los Altos Hills
Sunnyvale
Cupertino
Alviso

Figure 3-12. West County TWA overview

South County TWA. Two potential South County TWA options have been discussed with staff from Morgan Hill and Gilroy. The first TWA option would use water treated at a satellite WWTF and AWPF in Morgan Hill and then delivered to the Morgan Hill drinking water distribution system. It is likely this option would have a high life-cycle unit cost given the high level of treatment, lack of ROC management options, and limited yield. A second TWA option would use water treated at a new AWPF adjacent to SCRWA in Gilroy and deliver purified water to the Gilroy drinking water distribution system. This option would likely have similar limitations as the first South County TWA option and limit supply available for NPR use in Gilroy.

3.7 ROC Management Cost Summary

Valley Water's ROC Management Team separately developed ROC management strategies. Findings from their work, including costs, are summarized in the CoRe Plan and described in more detail in the *Evaluation of ROC Management Options Final Report* prepared by GHD (CoRe Plan Appendix G).

Section 4: Economic Assessment

The economic assessment of the feasible portfolios consists of cost estimates and a life-cycle evaluation capturing the full economic cost over a period of 30 and 100 years.

Two appendices are essential complements to the economic assessment:

- Appendix A-5: Basis of Cost, which documents inputs, assumptions, methods, and sources.
- Appendix A-6: Cost Estimates, which provide line-item costs for the AWPFs, pump stations, pipelines, interties, recharge ponds, and water supply source costs.

4.1 Life-Cycle Evaluation

The cost estimates summarized in Section 3 and provided in detail in Appendix A-6 form the basis of the life-cycle cost assessment. A life-cycle evaluation captures the full estimated present value cost to construct, implement, operate, and maintain a facility over a set period. One important element is incorporation of rates for both inflation and discounting. The inflation rate accounts for increases in price and decreases in purchasing value. The discount rate accounts for the time value of money and affects net present value (NPV) for projects with a significant difference between timing of benefits and costs (e.g., an initial investment followed by delayed benefits).

For its master plans, Valley Water uses a 30-year and 100-year life-cycle cost evaluation to compare and evaluate water supply alternatives, as described in detail in Appendix B of the WSMP 2040 (Valley Water, 2019b). The life-cycle evaluation evaluates the total cost and dollars per AF of each portfolio over a 30-year and 100-year life-cycle span. Costs consist of capital for AWPFs, pump stations, and pipelines; replacement and renewal (R&R) of major equipment; ROC Management; and O&M of new baseline project elements (i.e., consumable items related to treatment facilities, pump stations, pipelines, and water supplies). Table 4-1 identifies those costs that are included in the 30- and 100-year life-cycle evaluations.

Table 4-1. Costs Included in Life-Cycle Comparisons

Project Element	Description
Morgan Hill Option 1: NPR+[a]	Transmission pipeline from SBWR and distribution system to deliver NPR+ to Morgan Hill customers; source water cost
Morgan Hill Option 2: GWR[a]	Satellite plant in Morgan Hill with purified water pumped and piped from AWPF to San Pedro Recharge Ponds; ROC Management; and PR source water cost
Morgan Hill Option 3: SWA[a]	Satellite plant in Morgan Hill with purified water pumped and piped from AWPF to Anderson Reservoir; ROC Management; and PR source water cost
Portfolio 1a	San José AWPF for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1b	San José AWPF for RAW at Penitencia WTP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1c	San José AWPF for TWA to Milpitas Pipeline and North Santa Clara and San José; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 1d	San José AWPF for TWA to Piedmont Valve Yard and North Santa Clara and San José; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 2a	Combined regional AWPF in Palo Alto for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 2b	Combined supply to Sunnyvale AWPF for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost
Portfolio 4	Separate Palo Alto and Sunnyvale AWPFs for GWR at LGRP; conveyance infrastructure; ROC Management; and PR source water cost

a. *The Morgan Hill PR options do not satisfy Valley Water's goal of reaching 24,000 AF but are important potential projects that may accompany any of the North County portfolios.*

The following alternative elements were discussed in Section 2 and 3, though not considered in the life-cycle cost evaluations:

- NPR/NPR+ expansion projects, including treatment facilities (e.g., Sunnyvale AWPF for NPR+ and San José AWPF for expanded NPR+)
- Recycled water system interties
- Pipeline extension from LGRP to Rinconada WTP
- Alternative alignments from Palo Alto and/or Sunnyvale to LGRP (i.e., those shown in Section 2 and not reflected in Section 3 figures)

The life-cycle evaluation calculates present value costs. Present value costs convert future payments (e.g., costs that will need to be paid in 10 or 50 years) to today's dollars. It takes into consideration a fundamental principle of business finance: the time value of money, in which one dollar today has greater value than one dollar in the future. The time value of money is affected by inflation (i.e., decreasing purchasing power) and opportunity cost (i.e., foregoing money that could have been invested with compound interest to gain more money). The present value cost analysis evaluates future potential spend over a fixed period while controlling for inflation (3% per year) and for the discount rate (5.5% per year), which adjusts future cash flows to the present day.

Table 4-2 defines key concepts for the economic comparison of life cycles.

Table 4-2. References for Economic Comparison of Life Cycles	
Term	**Description**
Estimated capital	Estimated nominal (not accounting for inflation or discounting) capital costs for the entire life cycle, represented in August 2019 dollars
Estimated O&M	Estimated nominal (not accounting for inflation or discounting) O&M costs (e.g., energy, chemical, labor) for the entire life cycle, represented in August 2019 dollars Source water supply costs ($2.5M/year per portfolio) are included in this estimate. (Source water costs may be revisited pending agreements with publicly owned treatment facilities.)
Estimated R&R	Estimated nominal (not accounting for inflation or discounting) costs for R&R of major equipment, represented in August 2019 dollars
Total cost	Sum of estimated nominal (not accounting for inflation or discounting) capital, O&M, and R&R costs, represented in August 2019 dollars
Total cost, present value	Current value of estimated capital, O&M, and R&R costs that will be incurred over the project lifespan. Present value costs reflect Valley Water's real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in 2019 dollars. Real discount rate is consistent with Valley Water's unit cost of water methodology, as also used in the Expedited Purified Water Program Plan. Assumes construction begins in 2024 and operations begin in 2028
Total yield	Average water supply system yield, represented in thousand acre-feet (TAF) Assumes long-term annual yield per portfolio is 18,500 AFY (based on WEAP modeling of GWR and RWA alternatives performed for the Expedited Purified Water Program Plan. Yield from TWA has not yet been evaluated).
Present value yield	Per Valley Water's unit life-cycle approach, water supply system yields are discounted at the real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in AF
Life-cycle unit cost	Present value cost divided by the present value yield, represented in $/AF

Tables 4-3 and 4-4 contain estimated nominal costs and present value costs (represented in 2019 dollars), water supply system yields (represented in AF), and life-cycle unit costs (represented in $/AF) for the 30-year life cycles for each South County reuse option and North County portfolio, respectively. Tables 4-5 and 4-6 contain similar information for the 100-year life cycles.

Table 4-3. South County Reuse Options Economic Comparison Summary – 30-year Life Cycle			
	Option (M = millions)[a]		
	Option 1 (NPR+ from SBWR)	Option 2 (GWR)	Option 3 (SWA)

Table 4-3. South County Reuse Options Economic Comparison Summary – 30-year Life Cycle

	Option (M = millions)[a]		
	Option 1 (NPR+ from SBWR)	Option 2 (GWR)	Option 3 (SWA)
Excluding ROC Management			
Estimated capital	$70M	$75M	$95M
Estimated O&M	$80M	$205M	$215M
Estimated R&R	$5M	$35M	$40M
Total cost	$150M	$315M	$345M
Total cost, present value	$110M	$200M	$225M
Total yield (TAF)	87	57	57
Present value yield (TAF)	51	33	33
Life-cycle R&R cost ($/AF)	$100/AF	$500/AF	$600/AF
Unit cost ($/AF) excluding ROC Management	$2,200/AF	$6,100/AF	$6,900/AF
Including ROC Management[b]			
ROC management life-cycle unit cost ($/AF)	- -	$1,100/AF	$1,100/AF
Life-cycle unit cost including ROC management ($/AF)	$2,200/AF	$7,200/AF	$8,000/AF

a. *Values are rounded up to the nearest $5 million for capital costs; $100,000 for annual O&M costs; and $100/AF for life-cycle unit costs. Cost estimates are considered Class 5 by AACE International and have an accuracy of -50% to +100%.*

b. *ROC management unit costs from the Evaluation of ROC Management Options Final Report (Valley Water, 2020), included in Appendix G.*

Table 4-4. Portfolios Economic Comparison Summary – 30-year Life Cycle

	Portfolio (M = millions)[a]						
	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
Excluding ROC Management							
Estimated capital	$635M	$630M	$535M	$585M	$765M	$765M	$805M
Estimated O&M	$590M	$685M	$670M	$670M	$630M	$600M	$645M
Estimated R&R	$190M	$235M	$230M	$230M	$195M	$195M	$225M
Total cost	$1,415M	$1,545M	$1,435M	$1,485M	$1,590M	$1,560M	$1,670M
Total cost, present value	$975M	$1,045M	$955M	$1,000M	$1,110M	$1,095M	$1,170M
Total yield (TAF)	570 – 720	594 – 720	720	720	510 – 690	510 – 690	510 – 690
Present value yield (TAF)	331 –419	345 – 419	419	419	297 –401	297 – 401	297 – 401
Life-cycle R&R cost ($/AF)	$300/AF	$300 – $400/AF	$300/AF	$300/AF	$300 – $400 AF	$300/AF	$300 – $400 AF
Unit cost ($/AF) excluding ROC Management	$2,400 – $3,000/AF	$2,500 – $3,100/AF	$2,300/AF	$2,400/AF	$2,800 – $3,800/AF	$2,800 – $3,700/AF	$3,000 – $4,000/AF
Including ROC Management[b]							
ROC management life-cycle unit cost ($/AF)	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200 – $300/AF
Unit cost including ROC management ($/AF)	$2,600 – $3,200/AF	$2,700 – $3,300/AF	$2,500/AF	$2,600/AF	$3,000 – $4,000/AF	$3,000 – $3,900/AF	$3,200 – $4,300/AF

a. *Values are rounded up to the nearest $5 million for capital costs; $100,000 for annual O&M costs; and $100/AF for life-cycle unit costs. Cost estimates are considered Class 5 by AACE International and have an accuracy of -50% to +100%.*

b. *ROC management unit costs from the Evaluation of ROC Management Options Final Report (Valley Water, 2020), included in Appendix G.*

Table 4-5. South County Reuse Options Economic Comparison Summary – 100-year Life Cycle

	Option (M = millions)[a]		
	Option 1	Option 2	Option 3
Excluding ROC Management			
Estimated capital	$70M	$75M	$95M
Estimated O&M	$260M	$680M	$710M
Estimated R&R	$20M	$170M	$190M
Total cost	$350M	$925M	$995M
Total cost, present value	$145M	$315M	$345M
Total yield (TAF)	290	190	190
Present value yield (TAF)	90	59	59
Life-cycle R&R cost ($/AF)	$100/AF	$700/AF	$700/AF
Unit cost ($/AF) excluding ROC Management	$1,700/AF	$5,400/AF	$5,900/AF
Including ROC Management[b]			
ROC management life-cycle unit cost ($/AF)	- -	$700/AF	$700/AF
Unit cost including ROC management ($/AF)	$1,700/AF	$6,100/AF	$6,600/AF

a. *Values are rounded up to the nearest $5 million for capital costs; $100,000 for annual O&M costs; and $100/AF for life-cycle unit costs. Cost estimates are considered Class 5 by AACE International and have an accuracy of -50% to +100%.*

b. *ROC management unit costs from the Evaluation of ROC Management Options Final Report (Valley Water, 2020), included in Appendix G.*

Table 4-6. Portfolios Economic Comparison Summary – 100-year Life Cycle

	Portfolio (M = millions)[a]						
	Portfolio 1a	Portfolio 1b	Portfolio 1c	Portfolio 1d	Portfolio 2a	Portfolio 2b	Portfolio 4
Excluding ROC Management							
Estimated capital	$635M	$630M	$535M	$585M	$765M	$765M	$805M
Estimated O&M	$1,960M	$2,270M	$2,230M	$2,230M	$2,090M	$2,000M	$2,140M
Estimated R&R	$1,065M	$1,210M	$1,170M	$1,200M	$1,135M	$1,110M	$1,235M
Total cost	$3,660M	$4,110M	$3,935M	$4,015M	$3,990M	$3,875M	$4,180M
Total cost, present value	$1,365M	$1,495M	$1,395M	$1,440M	$1,525M	$1,495M	$1,605M
Total yield (TAF)	1,900 - 2,400	1,980 – 2,400	2,400	2,400	1,700 – 2,300	1,700 – 2,300	1,700 – 2,300
Present value yield (TAF)	587 – 742	612 – 742	742	742	526 – 711	526 – 711	526 – 711
Life-cycle R&R cost ($/AF)	$300 – $400/AF	$400 – $500/AF	$400/AF	$400/AF	$400 – $500/AF	$400 – $500/AF	$400 – $500/AF
Unit cost ($/AF) excluding ROC Management	$1,900 – $2,400/AF	$2,100 – $2,500/AF	$1,900/AF	$2,000/AF	$2,200 – $2,900/AF	$2,200 – $2,900/AF	$2,300 – $3,100/AF
Including ROC Management[b]							
ROC management life-cycle unit cost ($/AF)	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF	$200/AF
Unit cost including ROC management ($/AF)	$2,100 – $2,600/AF	$2,300 – $2,700/AF	$2,100/AF	$2,200/AF	$2,400 – $3,100/AF	$2,400 – $3,100/AF	$2,500 – $3,300/AF

a. *Values are rounded up to the nearest $5 million for capital costs; $100,000 for annual O&M costs; and $100/AF for life-cycle unit costs. Cost estimates are considered Class 5 by AACE International and have an accuracy of -50% to +100%.*

b. *ROC management unit costs from the Evaluation of ROC Management Options Final Report (Valley Water, 2020), included in Appendix G.*

Of the South County options, only Option 1 is cost-competitive with typical water supply costs. Of the North County portfolios, Portfolio 1a has the lowest life-cycle unit cost assuming no groundwater capacity limitations. Portfolio 1c has the next lowest life-cycle unit cost and does not rely on groundwater capacity.

Section 5: Portfolio Evaluation and Risk Assessment Tool

Because this TM is not intended to result in selection of a single recommended project, the Project Team has evaluated the portfolios and performed a relative comparison based on program goals, prioritization criteria, and risk management. The evaluation focuses on comparing features and attributes of the various portfolios and options that are key differentiators. Elements that apply across all alternatives—such as NPR/NPR+ distribution system expansions—affect each portfolio/option the same and thus are not considered in this comparison. Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. The risk tool assesses the likelihood and consequence of each risk and compiles them into a composite risk score for each portfolio.

5.1 Evaluation Criteria and Assessment Methodology

For this evaluation, prioritization criteria are consistent with those vetted and confirmed in Fall 2018 based on input from Partner Agencies and Valley Water staff, as presented in Appendix F: Conceptual Alternatives TM. The criteria from Appendix F were used to evaluate conceptual project portfolios with additional detail to further define sub-criteria. Evaluation criteria and initial weighting factors are summarized in Table 5-1.

Table 5-1. Evaluation Criteria and Weighting Factors

Criteria	Sub-criteria used to score criteria	Weighting Factor[a]
Economics	Unit cost of annual yield of PR supply, estimated life-cycle costs, funding capability, and grant funding eligibility	25%
Groundwater management and Countywide (regional) supply reliability	Projected PR supply, number of PR delivery points, seasonality, dry year drought reliability, and groundwater basin quality protection	25%
Environmental impacts/benefits and sustainability	Minimizing carbon footprint (evaluated using energy use as a surrogate for carbon emissions), environmental protection with respect to ROC MANAGEMENT, and environmental protection with respect to CEQA/NEPA impacts	20%
Ease of implementation and permitting/ regulatory considerations	Partnerships/collaboration, local ownership of reuse supply, operational simplicity, permitting/compliance (PR permits), permitting/compliance (CEQA/NEPA), readiness to proceed, public acceptance/support, and environmental and social justice	15%
Engineering feasibility	Tested and proven treatment technology, other water quality requirements	15%

a. *Initial criteria weighting from October 2018 Project Partner Group (PPG) meeting.*

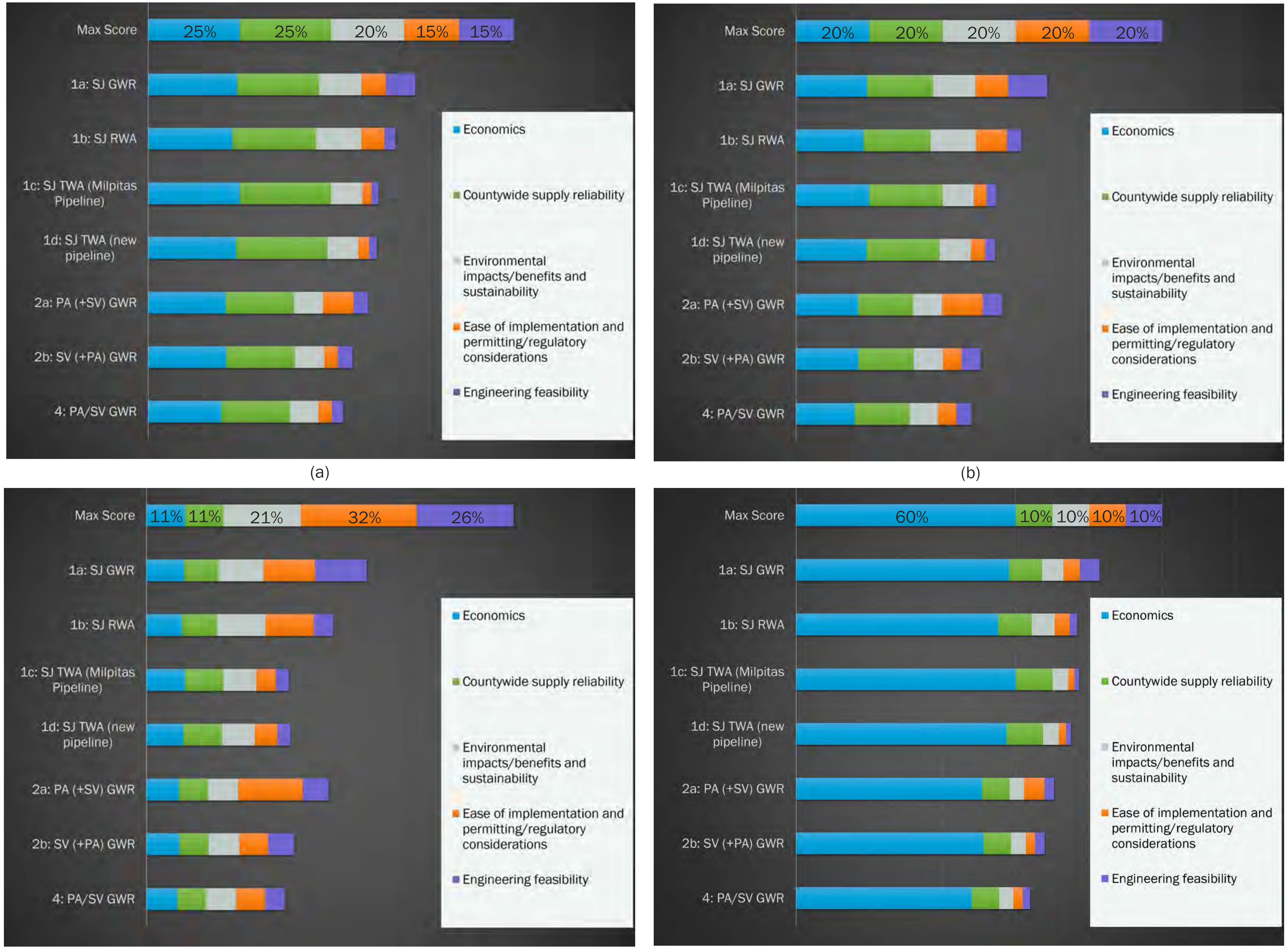
Prioritization criteria provide a framework for numerical evaluation, giving way to scores that provide a basis for preliminary ranking. The preliminary scoring presented in Appendix A-7 and shown graphically in this TM is for the purpose of discussion with Valley Water, Partner Agencies, and other stakeholders. The Project Team anticipates that these values will continue to be revised and refined with input from such discussions and new information, as it becomes available.

When considering the five primary criteria alone, the portfolios receive similar scores. The additional sub-criteria help to further illuminate relative strengths and weaknesses of each portfolio. Appendix A-7 defines sub-criteria and score ranges and explains how scores were normalized to compare portfolios.

As part of the analysis, the Project Team tested different ways of weighting the prioritization criteria and sub-criteria to illustrate the sensitivity of preliminary scoring to different criteria weightings. Changing weights of criteria altered portfolio scores in distinct ways, although the overall rankings did not change significantly. Figure 5-1 presents graphs illustrating scoring sensitivity to different criteria weightings:

- Initial criteria weighting from October 2018 PPG meeting (as presented in Table 5-1)
- Equal weighting of each criteria (i.e., each criterion weighted 20%)
- Equal weighting of each sub-criteria (i.e., each sub-criterion weighted 5.2%)
- Heavily weighted toward economics (substantially lopsided weighting for demonstration purposes only)

Finalized weightings will be decided with input from Valley Water executives and project partners.



(a) (b)

(c) (d)

Figure 5-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward economics

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Portfolio 1a (abbreviated SJ GWR in graph) receives the highest scores in all weighting scenarios, indicating how stable and well-balanced this portfolio is. Appendix A-7 includes more detailed discussion of weighting and sensitivity.

5.2 Risk Assessment Summary

Each portfolio carries associated potential risks: negative events or circumstances that could compromise the implementation or success of the Countywide reuse program and, thus, the ability to meet Valley Water's PR goals. The risk matrix (presented in Appendix A-7) supplements the scoring and evaluation process and presents relative risks of North County portfolios and South County options in one place. Example results from the risk assessment tool are presented in Figure 5.2.

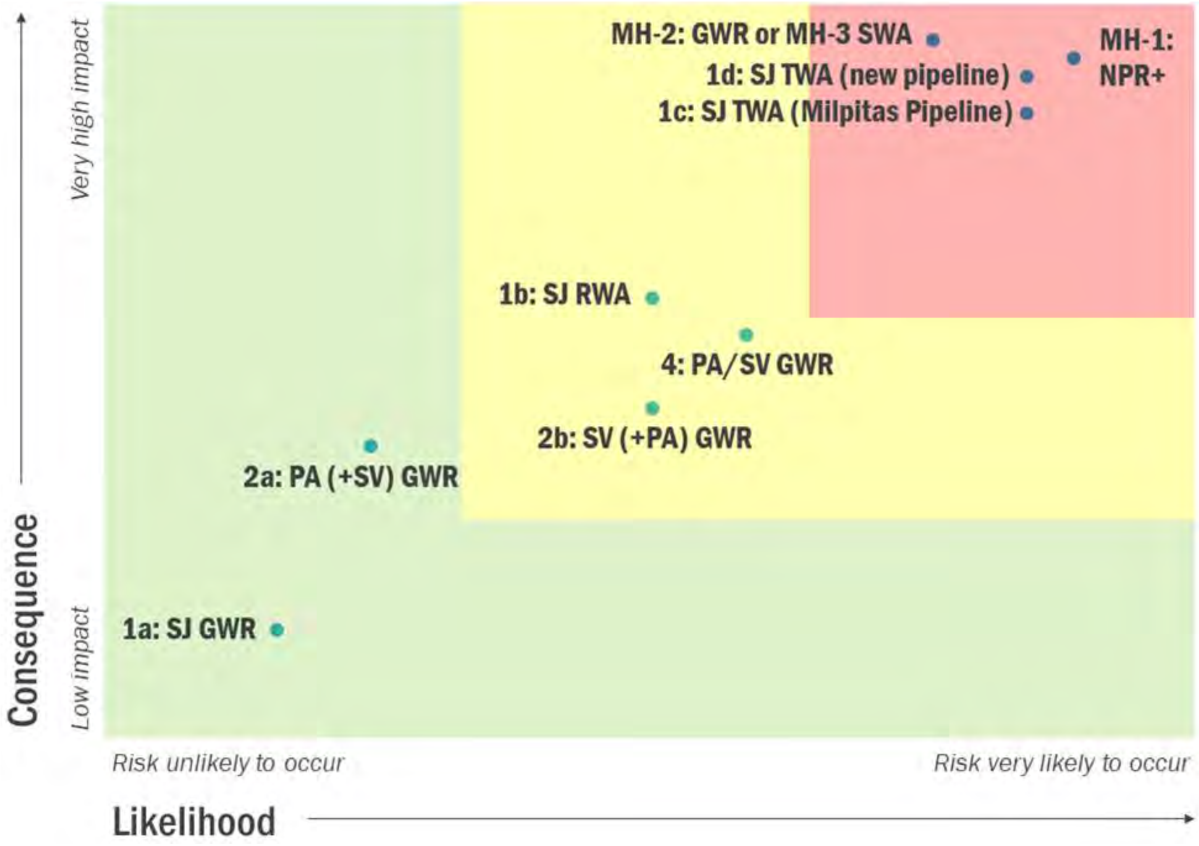

Figure 5-2. Example Risk Matrix comparison of portfolios and options with likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis

5.3 South County Elements Evaluation

South County elements include NPR from SCRWA, NPR+ via SBWR, and the Morgan Hill satellite WWTP and AWPF, which could be used for GWR at existing percolation ponds or SWA at Anderson Reservoir. These South County elements can be included in combination with any portfolio and, therefore, are evaluated separately. A numerical evaluation comparing the four South County alternatives was ruled out because NPR and PR options are not mutually exclusive, and each serves a separate purpose. Instead, a qualitative discussion of how South County elements perform with respect to the five criteria is presented in Appendix A-7 and summarized in Tables 5-2 and 5-3. The tables compare the two NPR options separately from the two

PR options; the more beneficial option for each criterion receives a 1 and the less beneficial option receives a 0, and if tied, both receive 0.5.

Table 5-2. South County NPR Options Qualitative Comparison

Criteria	Reference Point: Morgan Hill NPR from SCRWA	Option 1: Morgan Hill NPR+ from SBWR
Economics	0	1
Groundwater management and Countywide (regional) supply reliability	0	1
Environmental impacts/benefits and sustainability	0	1
Ease of implementation and permitting/ regulatory considerations	1	0
Engineering feasibility	0.5	0.5

Table 5-3. South County PR Options Qualitative Comparison

Criteria	Option 2: Morgan Hill GWR	Option 3: Morgan Hill SWA
Economics	1	0
Groundwater management and Countywide (regional) supply reliability	0	1
Environmental impacts/benefits and sustainability	0	1
Ease of implementation and permitting/ regulatory considerations	1	0
Engineering feasibility	1	0

5.4 Evaluation Sensitivity Analysis and Summary

Of the five portfolios focused on North County PR, Portfolio 1a received the highest scores for the criteria and sub-criteria and was the most "balanced" portfolio. It received some points for all criteria and most sub-criteria. Portfolios 1b, 1c, 1d, and 2a also performed well and, depending on criteria weighting, could be shown as the second, third, fourth, or fifth most favorable portfolio: scores were not as well balanced (scoring high for some criteria and not others) as for Portfolio 1a. The sensitivity analysis presented in Appendix A-7 shows that varying criteria weights does not significantly impact the order of Portfolio 1a, but it can impact other portfolios.

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Appendix A-2: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield

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201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925-937-9010
F: 925-937-9026

Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC Internal)

Contract no.: A4120A

Appendix A-2

Subject: Compendium of Flow Assessments, Facility Design Capacity, and Annual Yield

Date: June 30, 2020 (reissued April 19, 2021)

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, P.E., Brown and Caldwell Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

Prepared by: Katie Ruby, P.E., Brown and Caldwell
California License C90005

Reviewed by: Jenny Gain, P.E., Brown and Caldwell
California License C72430

Limitations:

This document was prepared solely for Santa Clara Valley Water District in accordance with professional standards at the time the services were performed and in accordance with the contract between Santa Clara Valley Water District and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Santa Clara Valley Water District; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Santa Clara Valley Water District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Table of Contents

Section 1: Flow Analysis 1
1.1 Methodology 1
  1.1.1 WWTP Influent 2
  1.1.2 NPR Demands, Environmental Flows, and Losses 4
  1.1.3 Remaining Effluent 7
1.2 Other Considerations 7
1.3 Results by Partner Agency 7
1.4 Monthly Flow Summaries 7
Section 2: AWPF Design Considerations 8
2.1 AWPF Sizing Methodology 8
2.2 Annual Yield 9
Attachment A: Flow Analysis Summaries by Partner Agency (North County) A
Attachment B: Monthly Flows by Partner Agency B
Attachment C: AWPF Sizing Calculations C

List of Figures

Figure 1. WWTP inflow and outflow streams considered in the flow analysis 2

List of Tables

Table 1. Range of Projected 2040 WWTP Influent Flows 3
Table 2. Current Flows: Baseline WWTP Influent and Monthly Distribution Factors 3
Table 3. Summary of Projected NPR Demands by Partner Agency 4
Table 4. Current Demands: NPR Demand and Monthly Distribution Factors for Each WWTP 5
Table 5. NPR+ Blending Requirements 6
Table 6. Annual Yield for PR 9

This document presents a compilation of data and assumptions that informed the flow analysis and advanced water purification facility (AWPF) sizing as part of Valley Water's Countywide Water Reuse Master Plan (Master Plan). Information is organized in two main sections.

- **Section 1: Flow Analysis.** Summarizes the approach for evaluating various flow streams at the four wastewater treatment plants (WWTP) and estimated amount of remaining effluent potentially available for potable reuse (PR).
- **Section 2: AWPF Design Considerations.** Summarizes AWPF design capacity, efficiency, and potential yield of purified water for PR, based on estimated source water available.

Section 1: Flow Analysis

Selection and design of AWPF project elements was informed by estimates of **remaining effluent** available from each of the four WWTPs in the county, after subtracting out other uses (e.g., non-potable reuse [NPR], environmental flows, and losses). The following section describes the general methodology for evaluating flows, followed by results by Partner Agency to demonstrate how the analysis played out for each WWTP.

1.1 Methodology

Using historical data and future flow projections, a flow balance was performed to estimate the remaining effluent available for discharge, blending, or additional reuse from each of the four WWTPs in Santa Clara County in 2040. As demonstrated in Figure 1 and further described below, the flow streams considered in the analysis included WWTP influent, NPR, environmental flows, and losses (e.g., evaporation). Because NPR expansion projects are already planned by each Partner Agency, the Master Plan assumes projected NPR demands will remain intact, and PR projects will be sourced by remaining effluent (minus any effluent reserved for discharge, blending, or other requirements).

**Definition:
remaining effluent**

Remaining effluent refers to the amount of secondary- or tertiary-treated wastewater available for potable reuse (or other uses such as discharge or blending) after non-potable reuse (NPR) demands, losses, and environmental flows are met. For planning purposes, the Master Plan assumes all remaining effluent would be available for potable reuse.

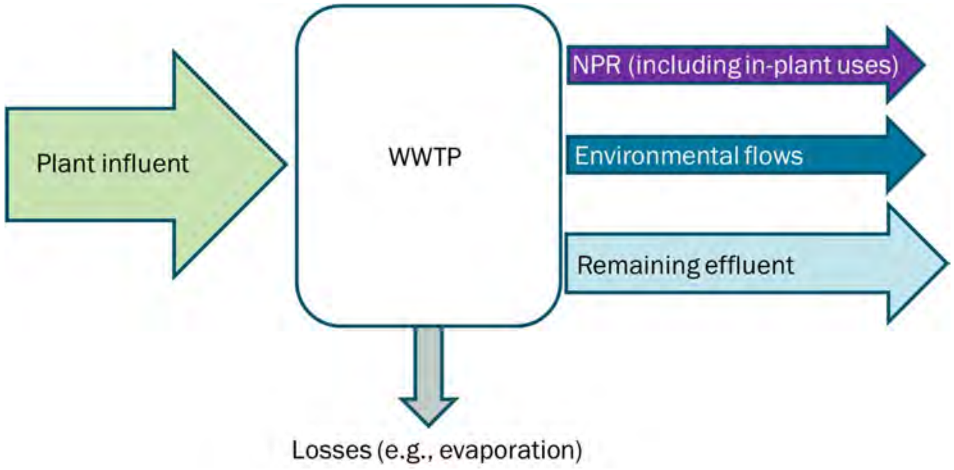

Figure 1. WWTP inflow and outflow streams considered in the flow analysis

1.1.1 WWTP Influent

Baseline conditions. Daily influent flows at each of the four WWTPs were downloaded from the California Integrated Water Quality System (CIWQS) database.[1] Average monthly median flows from 2014-2018 were used to establish baseline conditions.

Future projections of average dry weather flow. Partner Agencies' wastewater and recycled water master plans present future influent projections as average dry weather flow (ADWF), or the lowest consecutive three-month average. These plans were used as the starting point for estimating future influent projections in the Master Plan; however, the latest available planning documents were prepared prior to the recent extreme drought, and thus overestimated influent flows for 2015 onward. Recent trends suggest influent flows may not increase at rates previously projected, due to conservation and long-term water use efficiency.

Definition: average dry weather flow

Average dry weather flow (ADWF) is the average daily WWTP influent during the three lowest consecutive flow months of the year (e.g., June through August or July through September), typically presented in million gallons per day (mgd).

To account for the uncertainty in future influent projections (due to changes in water use/land use and population growth/density), the Master Plan considers a range of future flow conditions by starting with influent projections through 2035[2] from Partner Agencies' planning documents, adjusting downward to match the 2014-2018 baseline and considering a range of flows:

- Lower bound – assumes no increase from baseline (flatlined projection).
- Upper bound – assumes same slope (i.e., rate of increase) from Partner Agencies' planning documents. (If the planning document included multiple projection curves, the flattest slope was applied).

The resulting 2040 ADWF projections used in the Master Plan are summarized in Table 1.

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[1] https://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical#

[2] Although 2040 is the planning horizon for the Master Plan, 2035 was used for the influent flow analysis based on projections available in Partner Agencies' planning documents. Using 2035 also provides a more conservative estimate of available flow, since influent will likely remain constant or increase between 2035 and 2040 (according to current projections).

Table 1. Range of Projected 2040 WWTP Influent Flows

WWTP	Projected ADWF (mgd), using 2014-2018 baseline [a]	
	Lower Bound: Flatlined Projection	Upper Bound: Increasing ADWF [b]
San José/Santa Clara Regional Wastewater Facility (RWF)	98.4	106
Palo Alto Regional Water Quality Control Plant (RWQCP)	17.7	19.6
Sunnyvale Water Pollution Control Plant (WPCP)	11.2 [c]	15.9
South County Regional Wastewater Authority (SCRWA)	6.0 [d]	6.0 [d]

a. *ADWF was calculated using average of monthly median flows from 2014-2018. Influent flow data was downloaded from the CIWQS database.*

b. *Rate of increase based on slopes from individual agencies' influent projection curves (in past wastewater or recycled water plans) through 2035 (timeframe of available projections).*

c. *Actual Sunnyvale WPCP influent is approximately 0.5 mgd lower than the values reported in CIWQS, due to a difference in metering location.*

d. *SCRWA WWTP influent was already projected to remain constant over time (at approximately 6 mgd), so the lower and upper bound projections are the same.*

Converting ADWF to Monthly Flow Projections. By definition, ADWF values do not reflect the higher flows of winter months. To account for seasonal variation in flow, future ADWF was converted to monthly flows, using monthly distribution factors based on historical flow data. (Note: this conversion was only necessary for the upper bound of future influent projections, since the lower bound is already reflective of historical conditions.)

Monthly distribution factors were calculated for each WWTP by dividing historical (baseline) monthly flows by the lowest consecutive three-month average. These factors were then multiplied by future projected ADWF to estimate future monthly influent.

Historical (baseline) monthly influent and the resulting distribution factors (monthly flow divided by ADWF) are summarized in Table 2.

Table 2. Current Flows: Baseline WWTP Influent and Monthly Distribution Factors

Month	SJ/SC RWF		Palo Alto RWQCP		Sunnyvale WPCP[a]		SCRWA WWTP	
	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor	Baseline Influent (mgd)[b]	Monthly Distribution Factor
Jan.	103.7	1.1	21.0	1.2	12.8	1.1	6.7	1.1
Feb.	104.1	1.1	21.9	1.2	12.9	1.2	7.2	1.2
March	104.5	1.1	21.6	1.2	13.0	1.2	7.0	1.2
April	101.7	1.0	20.4	1.2	12.3	1.1	6.6	1.1
May	98.8	1.0	19.7	1.1	11.9	1.1	6.3	1.1
June	99.7	1.0	19.0	1.1	11.7	1.0	6.1	1.0
July	98.3	1.0	17.9	1.0	11.3	1.0	6.0	1.0
Aug.	100.2	1.0	17.8	1.0	11.3	1.0	6.0	1.0
Sep.	99.0	1.0	17.5	1.0	11.1	1.0	5.9	1.0
Oct.	99.1	1.0	17.8	1.0	11.1	1.0	5.9	1.0
Nov.	97.3	1.0	17.9	1.0	11.3	1.0	6.0	1.0
Dec.	99.3	1.0	19.0	1.1	12.0	1.1	6.1	1.0
ADWF	98.4		17.7		11.2		6.0	

a. *Sunnyvale WPCP influent values in CIWQS include approximately 0.5 mgd of internal plant recycle (as clarified by Sunnyvale staff) and do not reflect actual flow into the plant. Thus, the values from CIWQS were reduced by 0.5 mgd to represent plant influent more accurately.*

b. *Baseline influent = average of monthly median flows, 2014-2018.*

1.1.2 NPR Demands, Environmental Flows, and Losses

The following outflow streams were considered for each WWTP, based on current and projected future uses.

Non-potable reuse. 2015 Urban Water Management Plans (UWMP), developed by water suppliers in coordination with recycled water producers, generally contain the most recent NPR demand projections and were, therefore, used as the basis for future NPR, with a few exceptions:

- South Bay Water Recycling (SBWR) provided updated NPR projections in January 2019, representing increased recycled water demand across the service area.
- Morgan Hill’s 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, the Master Plan uses Morgan Hill’s conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

For more detailed information on potential future NPR projects, such as target customer areas and recommended pipeline alignments, water retailers’ individual recycled water planning documents were reviewed (as referenced in Appendix A-1, Table 2-15); however, these plans generally predate the 2015 UWMPs, and the total projected NPR demands do not always align. In the case of discrepancies, NPR demand projections from 2015 UWMPs were used (unless otherwise specified).

NPR demand projections by Partner Agency are summarized in Table 3. Though typically presented as annual volumes (in acre-feet per year [AFY]) for planning purposes, Table 3 also shows demands in mgd for reference. These demands include recycled water used in and around the Palo Alto RWQCP and SCRWA WWTP. They do not necessarily reflect contractual obligations (e.g., Mountain View is entitled to up to 3 mgd from Palo Alto [an instantaneous value], though average projected NPR use is lower). Current contractual obligations are noted in Table 3 and discussed further in Section 1.2 (Other Considerations).

Table 3. Summary of Projected NPR Demands by Partner Agency

Partner Agency	Water Retailers	2040 NPR Demand [a] AFY	2040 NPR Demand [a] mgd (annual average)	Current Contractual Obligation [b]
PA/MV RWS	City of Palo Alto City of Mountain View	2,800	2.5	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	City of Sunnyvale California Water Service Company (Cal Water) (Cupertino) San Jose Water (Cupertino)	1,700	1.5	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale’s city limits
SBWR	City of Santa Clara San José Municipal Water System (SJMWS) San Jose Water City of Milpitas	30,900 [c]	27.6 [c]	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline (through January 22, 2027, unless a new agreement is established)
SCRWA	City of Gilroy City of Morgan Hill	3,700 2,900[d]	3.3 2.6[d]	SCRWA may sell flows of recycled water that exceed the annual delivery quantity (a mutually agreed-upon flow established each year) to other wholesalers and Valley Water may sell recycled water to be used by end users outside of the South County RWS service area (with SCRWA’s approval)
County total		42,000	37.5	

a. *Projected 2040 NPR demands from water retailers’ 2015 UWMPs, rounded to the nearest 100 AFY unless otherwise specified.*

b. *Projected NPR demands do not fully capture potential allocations per contractual agreements.*

c. *Updated NPR demands provided by SBWR staff in January 2019.*

d. *Morgan Hill’s conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.*

PA/MV = Palo Alto/Mountain View; RWS = recycled water system

Although future NPR projections are presented as average annual demands, NPR use varies seasonally. Therefore, similar to the process for converting future ADWF to monthly influent projections, monthly distribution factors were used to estimate future monthly NPR demand.

Average historical monthly NPR demands (based on 2015-2017 data provided by partner agencies) were divided by average annual demand to calculate a monthly factor. Historical monthly NPR demands and the resulting distribution factors are shown in Table 4. These factors were then multiplied by projected annual NPR demand to estimate future monthly NPR demand.

Table 4. Current Demands: NPR Demand and Monthly Distribution Factors for Each WWTP

	San José/Santa Clara RWF		Palo Alto RWQCP		Sunnyvale WPCP		SCRWA WWTP	
Month	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor	NPR demand (2015-17 average, mgd)	Monthly Distribution Factor
Jan.	6.7	0.6	0.1	0.2	0.4	0.4	1.2	0.7
Feb.	6.5	0.5	0.2	0.3	0.4	0.5	1.0	0.5
March	7.4	0.6	0.3	0.4	0.6	0.7	1.4	0.8
April	9.6	0.8	0.5	0.9	0.9	1.0	1.7	0.9
May	13.6	1.1	0.9	1.4	1.2	1.3	2.0	1.1
June	17.9	1.5	1.0	1.7	1.5	1.7	2.6	1.4
July	19.5	1.6	1.1	1.8	1.4	1.6	2.8	1.5
Aug.	19.0	1.6	1.2	2.0	1.5	1.7	2.9	1.6
Sep.	17.2	1.4	1.0	1.6	1.4	1.5	2.2	1.2
Oct.	14.3	1.2	0.7	1.1	0.9	1.0	1.9	1.0
Nov.	7.4	0.6	0.2	0.4	0.3	0.4	1.3	0.7
Dec.	5.9	0.5	0.2	0.3	0.2	0.2	1.2	0.6
Average	12.1		0.6		0.9		1.9	

Losses associated with enhanced NPR (NPR+). To improve water quality of recycled water in terms of target levels of total dissolved solids (TDS), purified water can be blended with Title 22 recycled water, resulting in enhanced NPR or NPR+.

SBWR is currently the only Partner Agency that delivers NPR+, which meets a TDS target of less than 500 milligrams per liter (mg/L) by blending purified water from the Silicon Valley Advanced Water Purification Center (SVAWPC) with Title 22 recycled water.

Palo Alto is planning a local AWPF for NPR+. Additionally, if NPR systems in North County were connected through interties, Sunnyvale may also consider an AWPF to provide water quality consistent with SBWR and PA/MV systems. Therefore, the flow analysis for systems in

Definition:
enhanced NPR (NPR+)

Enhanced NPR, or NPR+, is achieved by blending Title 22 recycled water with purified water for improved water quality (e.g., TDS <500 mg/L). The lower salinity of NPR+ compared to Title 22 recycled water makes it more suitable certain non-potable uses (e.g., landscape irrigation).

North County considers not just NPR demand but the effluent required for NPR+, which accounts for the additional treatment losses (i.e., reverse osmosis concentrate [ROC]) associated with the advanced treatment process. (Note: the analysis assumes microfiltration/ultrafiltration [MF/UF] backwash returns to the front of the plant.)

The amount of purified water required for blending varies by facility, given the range in effluent TDS at each WWTP. The purified water required per unit of effluent (shown in Table 5 below) was calculated using existing water quality data and assuming a target TDS of 500 mg/L. Assuming an RO recovery rate of 85 percent, ROC is then calculated as:

$$ROC = (1 - 0.85) * \left(\frac{\text{purified water needed for blending}}{0.85}\right)$$

Table 5. NPR+ Blending Requirements

WWTP	Effluent TDS (mg/L)	Purified Water Flow per Unit Effluent Flow	Purified Water Flow Percent
PA RWQCP	847[a]	0.771	43.5%
Sunnyvale WPCP	930[b]	0.956	48.9%
SJ/SC RWF	720[c]	0.489	32.8%

a. *Average of TDS readings from 2015–17, as reported to California State Water Resources Control Board.*

b. *Average TDS from 2007–11 per City of Sunnyvale Feasibility Study for Recycled Water Expansion (FSRWE) (June 2013).*

c. *Per SBWR's 2014 SMP, Appendix 4A.*

Because South County does not have any planned NPR+, the flow analysis assumes SCRWA will continue producing the same quality recycled water for NPR.

Environmental flow requirements. Currently, Palo Alto RWQCP is the only WWTP in the county obligated to provide flow for environmental benefit under National Pollutant Discharge Elimination System (NPDES) permit requirements. Approximately 1 mgd of RWQCP effluent is provided to the Renzel Marsh project. In the future, Renzel Marsh may be expanded, and additional flow may be needed for horizontal levees and discharge through the main outfall. The flow analysis for 2040 assumes 3 mgd year-round to account for all environmental flows from the Palo Alto RWQCP.

No environmental flow requirements were identified for the SJ/SC RWF, Sunnyvale WPCP, or SCRWA WWTP.

Other losses. While treatment losses at the WWTPs were generally assumed to be negligible, unless otherwise specified the following losses were considered at the Palo Alto RWQCP and Sunnyvale WPCP per input from their respective staff.

- **Palo Alto RWQCP – 0.3 mgd lost from recirculated flow.** The Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash), and experiences a 20 percent loss of the recirculated flow, which equates to approximately 0.3 mgd. (Note: recycled water for in-plant uses is captured within the NPR demands).
- **Sunnyvale WPCP – 4 mgd for evaporation and capping.** The Sunnyvale WPCP experiences some evaporative losses associated with the use of ponds as part of its treatment process. Current evaporative losses are typically between 1 and 2 mgd. Future average losses at the Sunnyvale WPCP associated with its pond system are assumed to be 4 mgd, including flows for capping, evaporation, and other losses. Although these losses may vary seasonally (e.g., higher evaporation in summer), the flow analysis assumes 4 mgd year-round as a conservative estimate.

1.1.3 Remaining Effluent

Remaining effluent (i.e., WWTP influent minus losses, environmental flows, and NPR demands) may be available for discharge, blending, or additional reuse. Currently, remaining effluent in North County is discharged to the San Francisco Bay, while South County effluent is sent to percolation ponds or discharged to the Pajaro River (and eventually Monterey Bay) in rainy months.

For the purpose of this planning-level estimate, it was assumed that all remaining effluent was available for PR, and potential AWPFs were sized accordingly.

1.2 Other Considerations

Contractual obligations. As noted above, the flow analysis is based on projected water use and does not necessarily reflect current contractual arrangements. For example, Mountain View is entitled to up to 3 mgd from Palo Alto, though this is not captured in the NPR demands as projected NPR is lower. Contractual obligations are noted where applicable throughout the Master Plan and considered as part of the portfolio evaluation and risk assessment. New or revised agreements may be required for certain project elements or portfolios to proceed.

Discharge, blending, or other requirements. The flow analysis only considered current and planned uses of effluent and did not incorporate other potential future uses, such as blending for ROC management. For the initial planning-level estimate, it was assumed all remaining effluent would be available for PR. If other requirements arise, it may reduce the available effluent at certain times of the year.

Onsite reuse. The extent of future onsite (decentralized) reuse in the County may have implications for centralized reuse facilities. While onsite reuse projects can promote public awareness of water reuse and offer potential energy savings, they also reduce the amount of wastewater available for potable reuse and could lead to higher solids concentrations in sewers. Four onsite reuse projects are under development in Mountain View, with potential additional projects being explored elsewhere in the County. Future onsite reuse efforts will require coordination among multiple stakeholders, including Valley Water and the Partner Agencies, to evaluate potential impacts on the Master Plan.

1.3 Results by Partner Agency

Though the approach for evaluating available flow was similar for each Partner Agency, each WWTP has unique conditions and requirements. To confirm and refine assumptions with each Partner Agency, the Project Team summarized results from the analysis in a slidedoc format for each WWTP in North County and reviewed with Partner Agency staff. These slidedocs present flow availability under different scenarios and are included herein as Attachment A.

For South County, the potable reuse options evaluated in the Master Plan include satellite treatment in Morgan Hill, rather than sourcing a new AWPF with effluent from SCRWA WWTP. Therefore, the flow analysis considered wastewater available in Morgan Hill rather than performing a flow balance at SCRWA WWTP.

1.4 Monthly Flow Summaries

Projected monthly flow streams at each WWTP are summarized in Attachment B, including estimated effluent available for reuse and the resulting purified water yield (based on selected AWPF capacity, as discussed in Section 2).

Section 2: AWPF Design Considerations

The flow analysis informed potential AWPF design capacities and potential yield of purified water for PR, as described below.

2.1 AWPF Sizing Methodology

Potential AWPFs were sized to maximize production of purified water for PR (up to Valley Water's 24,000 AFY goal) while maintaining a reasonable **efficiency**. Attachment C includes summary tables that show anticipated yield and AWPF efficiency at various production capacities. These tables informed the selected design capacity for each potential AWPF.

Definition: efficiency

Efficiency of an AWPF, also called "AWPF utilization", is calculated as purified water produced divided by the facility's design capacity. Efficiency takes into account the AWPF's **online factor** (i.e., percent of time equipment is online vs. offline for regular maintenance) as well as source water availability.

Incremental efficiency refers to the additional purified water that would be produced relative to an increase in design capacity (e.g., if increasing the capacity of an AWPF by 2 mgd would produce an additional 1 mgd of purified water on average, the incremental efficiency would be 50%).

Because the SJ/SC RWF has sufficient effluent available to produce 24,000 AFY for PR, the potential new AWPF in San José was sized at 24 mgd production capacity (assuming a 90 percent online factor). In other words, although the plant would have capacity to produce 24 mgd (equivalent to nearly 27,000 AFY if operating 365 days/year), the design assumes the AWPF will be online 90 percent of the time and produce an annual volume of 24,000 AF.

In Palo Alto and Sunnyvale, there likely will not be enough effluent available to produce 24,000 AFY of purified water; therefore, for portfolios with a potential new AWPF in Palo Alto and/or Sunnyvale, AWPFs were sized considering **incremental efficiency** (i.e., the additional purified water produced relative to the increase in design capacity, or "bang for the buck"). Beyond a certain design capacity, there are diminishing returns—that is, adding more capacity yields relatively little additional purified water and may not be worth the additional cost.

For example, the proposed 14-mgd AWPF in Palo Alto is expected to yield approximately 13,200 AFY of purified water (84 percent efficiency). If solely aiming to maximize purified water production, the AWPF could be sized at 16 mgd (estimated yield = 13,600 AFY at 76 percent efficiency). However, the additional 2 mgd capacity only yields an additional 400 AFY in purified water (<20% incremental efficiency).

Because there are multiple months throughout the year during which the AWPF would be operating below capacity (i.e., AWPF efficiency is limited by source flow), it was assumed that offline activities (e.g., clean-in-place, maintenance) would occur during those times, as long as the AWPF efficiency is less than the assumed online factor of 90 percent.

For preliminary designs, the "upper bound" of influent (and resulting effluent available) was used for AWPF sizing. Under "lower bound" conditions, the AWPFs in Palo Alto and Sunnyvale would be downsized to maintain a reasonable efficiency. Given uncertainty in future flow availability, the intent is for AWPFs to be constructed modularly to allow for incremental expansion if and when more flow becomes available.

2.2 Annual Yield

Potential purified water yields (based on source water availability and selected AWPF capacity) are shown in Table 6 for each potential AWPF. More detailed results of the AWPF sizing calculation, including selected capacity, efficiency, and anticipated yield are included in Attachment C. These results demonstrate how each portfolio would contribute to Valley Water's goal of 24,000 AFY of purified water for PR.

The values presented in Table 6 are based on source water availability and assume no limitations at the delivery point. However, during wet years, purified water yield may be limited by groundwater levels and the availability of other water supplies. Valley Water's Water Evaluation and Planning (WEAP) model indicates average capacity of the groundwater basin (over a range of hydrologic years) will limit long-term average yield to 18,500 AFY for portfolios involving groundwater recharge.[3]

Definition:
Yield

Yield, often presented as an annual volume, is the amount of purified water produced for PR. Yield is generally lower than the maximum production (design) capacity due to source water availability, maintenance, and other factors that affect AWPF efficiency.

Table 6. Annual Yield for PR

Facility	Potential Yield (AFY) [a]
Portfolio 1 - San José AWPF	24,000
Portfolio 2 - Combined Regional AWPF (in Palo Alto or Sunnyvale)	17,300 [b] – 23,000
Portfolio 4 - Separate Palo Alto AWPF	11,700 – 13,200
Portfolio 4 - Separate Sunnyvale AWPF	5,500 – 9,800
Morgan Hill Satellite AWPF	1,900

a. *Discussions around source water availability and potential purified water yield are ongoing. Yield may be lower during drought conditions or other scenarios.*

b. *Lower bound for Portfolios 2 and 4 differ due to rounding.*

Annual yields are estimated for planning purposes and cannot be guaranteed; however, some portfolios are more sensitive to changes in future flow conditions than others, as captured in Appendix A-7: Evaluation and Risk Assessment Tool. Based on projected flow conditions, Portfolio 1 (AWPF in San José) is the only option likely to meet the 24,000 AFY goal. Though Portfolios 2 and 4, which rely on flow from Palo Alto and Sunnyvale, have limited effluent availability and may not produce 24,000 AFY, they would still contribute to the CoRe Plan's overall objective of improving water supply reliability for the region through reuse.

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[3] Valley Water, 2018. *Expedited Purified Water Program Plan Final Report.*

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Attachment A: Flow Analysis Summaries by Partner Agency (North County)

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Attachment B: Monthly Flows by Partner Agency

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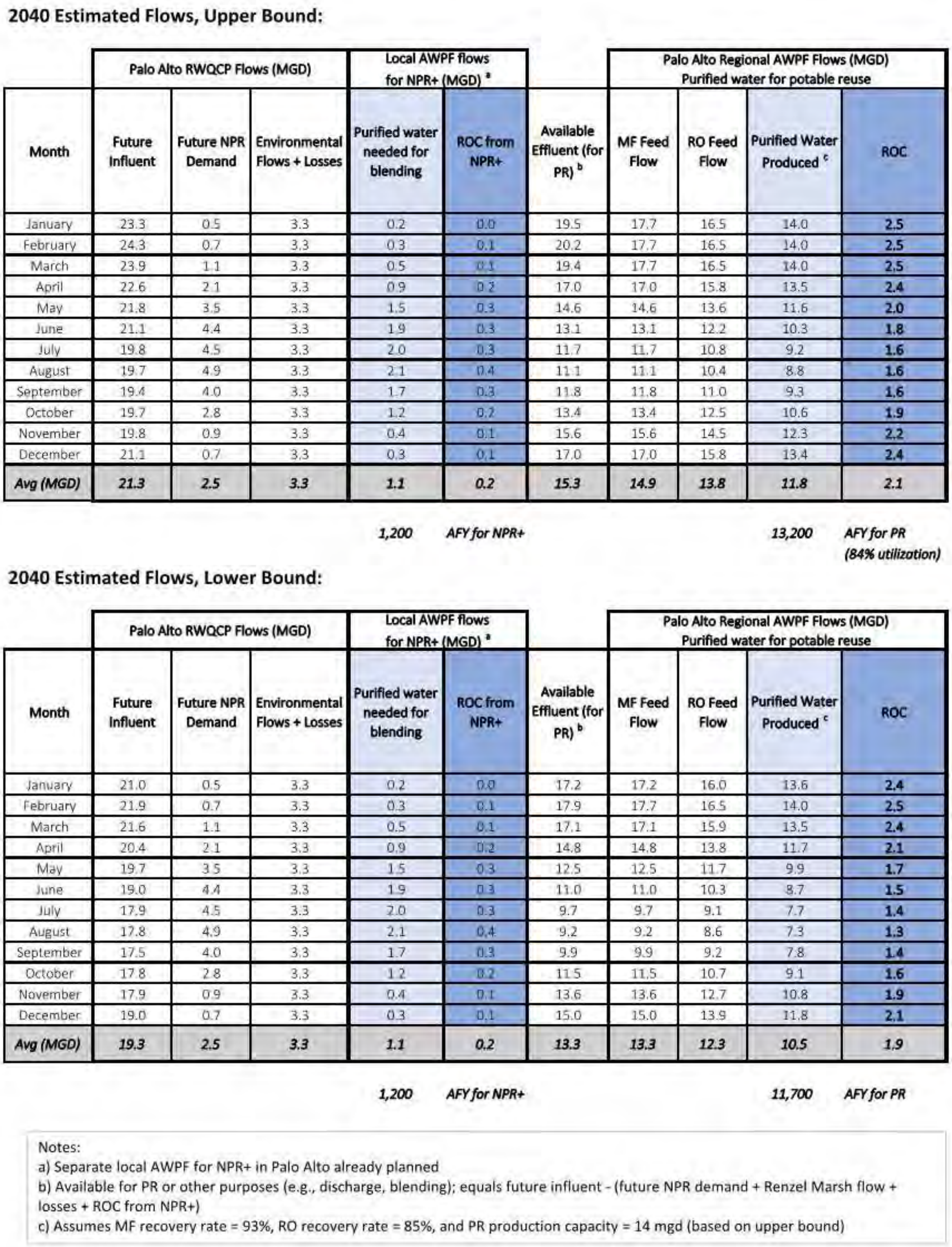
Table B-1. Palo Alto Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2040 Estimated Flows, Upper Bound:

	Palo Alto RWQCP Flows (MGD)			Local AWPF flows for NPR+ (MGD) [a]			Palo Alto Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	Future Influent	Future NPR Demand	Environmental Flows + Losses	Purified water needed for blending	ROC from NPR+	Available Effluent (for PR) [b]	MF Feed Flow	RO Feed Flow	Purified Water Produced [c]	ROC
January	23.3	0.5	3.3	0.2	0.0	19.5	17.7	16.5	14.0	2.5
February	24.3	0.7	3.3	0.3	0.1	20.2	17.7	16.5	14.0	2.5
March	23.9	1.1	3.3	0.5	0.1	19.4	17.7	16.5	14.0	2.5
April	22.6	2.1	3.3	0.9	0.2	17.0	17.0	15.8	13.5	2.4
May	21.8	3.5	3.3	1.5	0.3	14.6	14.6	13.6	11.6	2.0
June	21.1	4.4	3.3	1.9	0.3	13.1	13.1	12.2	10.3	1.8
July	19.8	4.5	3.3	2.0	0.3	11.7	11.7	10.8	9.2	1.6
August	19.7	4.9	3.3	2.1	0.4	11.1	11.1	10.4	8.8	1.6
September	19.4	4.0	3.3	1.7	0.3	11.8	11.8	11.0	9.3	1.6
October	19.7	2.8	3.3	1.2	0.2	13.4	13.4	12.5	10.6	1.9
November	19.8	0.9	3.3	0.4	0.1	15.6	15.6	14.5	12.3	2.2
December	21.1	0.7	3.3	0.3	0.1	17.0	17.0	15.8	13.4	2.4
Avg (MGD)	***21.3***	***2.5***	***3.3***	***1.1***	***0.2***	***15.3***	***14.9***	***13.8***	***11.8***	***2.1***

1,200 ***AFY for NPR+***

13,200 ***AFY for PR (84% utilization)***

2040 Estimated Flows, Lower Bound:

	Palo Alto RWQCP Flows (MGD)			Local AWPF flows for NPR+ (MGD) [a]			Palo Alto Regional AWPF Flows (MGD) Purified water for potable reuse			
Month	Future Influent	Future NPR Demand	Environmental Flows + Losses	Purified water needed for blending	ROC from NPR+	Available Effluent (for PR) [b]	MF Feed Flow	RO Feed Flow	Purified Water Produced [c]	ROC
January	21.0	0.5	3.3	0.2	0.0	17.2	17.2	16.0	13.6	2.4
February	21.9	0.7	3.3	0.3	0.1	17.9	17.7	16.5	14.0	2.5
March	21.6	1.1	3.3	0.5	0.1	17.1	17.1	15.9	13.5	2.4
April	20.4	2.1	3.3	0.9	0.2	14.8	14.8	13.8	11.7	2.1
May	19.7	3.5	3.3	1.5	0.3	12.5	12.5	11.7	9.9	1.7
June	19.0	4.4	3.3	1.9	0.3	11.0	11.0	10.3	8.7	1.5
July	17.9	4.5	3.3	2.0	0.3	9.7	9.7	9.1	7.7	1.4
August	17.8	4.9	3.3	2.1	0.4	9.2	9.2	8.6	7.3	1.3
September	17.5	4.0	3.3	1.7	0.3	9.9	9.9	9.2	7.8	1.4
October	17.8	2.8	3.3	1.2	0.2	11.5	11.5	10.7	9.1	1.6
November	17.9	0.9	3.3	0.4	0.1	13.6	13.6	12.7	10.8	1.9
December	19.0	0.7	3.3	0.3	0.1	15.0	15.0	13.9	11.8	2.1
Avg (MGD)	***19.3***	***2.5***	***3.3***	***1.1***	***0.2***	***13.3***	***13.3***	***12.3***	***10.5***	***1.9***

1,200 ***AFY for NPR+***

11,700 ***AFY for PR***

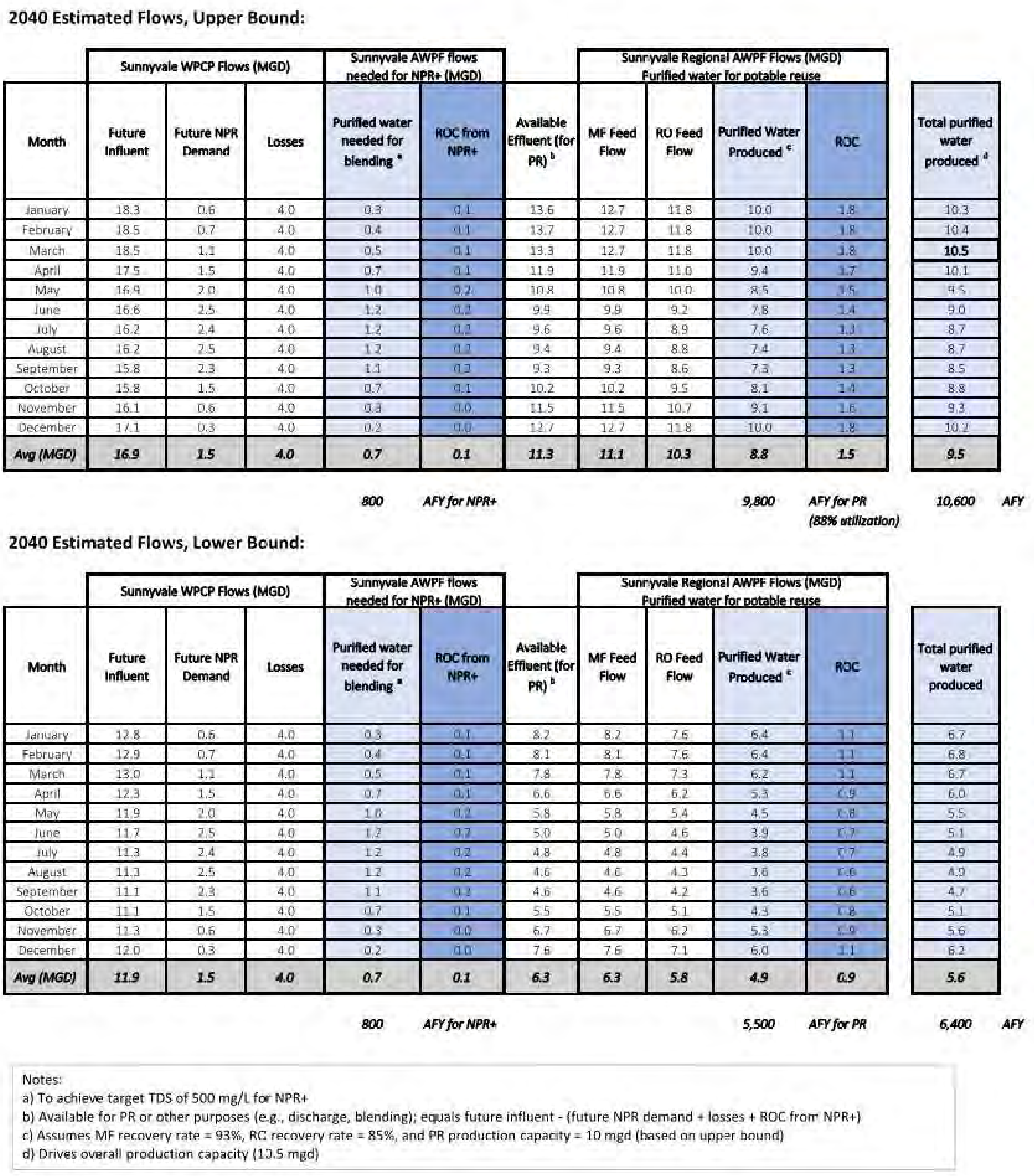
Notes:

a) Separate local AWPF for NPR+ in Palo Alto already planned

b) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand + Renzel Marsh flow + losses + ROC from NPR+)

c) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 14 mgd (based on upper bound)

Table B-2. Sunnyvale Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2040 Estimated Flows, Upper Bound:

	Sunnyvale WPCP Flows (MGD)			Sunnyvale AWPF flows needed for NPR+ (MGD)			Sunnyvale Regional AWPF Flows (MGD) Purified water for potable reuse				
Month	**Future Influent**	**Future NPR Demand**	**Losses**	**Purified water needed for blending [a]**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**	**Total purified water produced [d]**
January	18.3	0.6	4.0	0.3	0.1	13.6	12.7	11.8	10.0	1.8	10.3
February	18.5	0.7	4.0	0.4	0.1	13.7	12.7	11.8	10.0	1.8	10.4
March	18.5	1.1	4.0	0.5	0.1	13.3	12.7	11.8	10.0	1.8	**10.5**
April	17.5	1.5	4.0	0.7	0.1	11.9	11.9	11.0	9.4	1.7	10.1
May	16.9	2.0	4.0	1.0	0.2	10.8	10.8	10.0	8.5	1.5	9.5
June	16.6	2.5	4.0	1.2	0.2	9.9	9.9	9.2	7.8	1.4	9.0
July	16.2	2.4	4.0	1.2	0.2	9.6	9.6	8.9	7.6	1.3	8.7
August	16.2	2.5	4.0	1.2	0.2	9.4	9.4	8.8	7.4	1.3	8.7
September	15.8	2.3	4.0	1.1	0.2	9.3	9.3	8.6	7.3	1.3	8.5
October	15.8	1.5	4.0	0.7	0.1	10.2	10.2	9.5	8.1	1.4	8.8
November	16.1	0.6	4.0	0.3	0.0	11.5	11.5	10.7	9.1	1.6	9.3
December	17.1	0.3	4.0	0.2	0.0	12.7	12.7	11.8	10.0	1.8	10.2
Avg (MGD)	***16.9***	***1.5***	***4.0***	***0.7***	***0.1***	***11.3***	***11.1***	***10.3***	***8.8***	***1.5***	***9.5***

800 *AFY for NPR+* *9,800* *AFY for PR (88% utilization)* *10,600* *AFY*

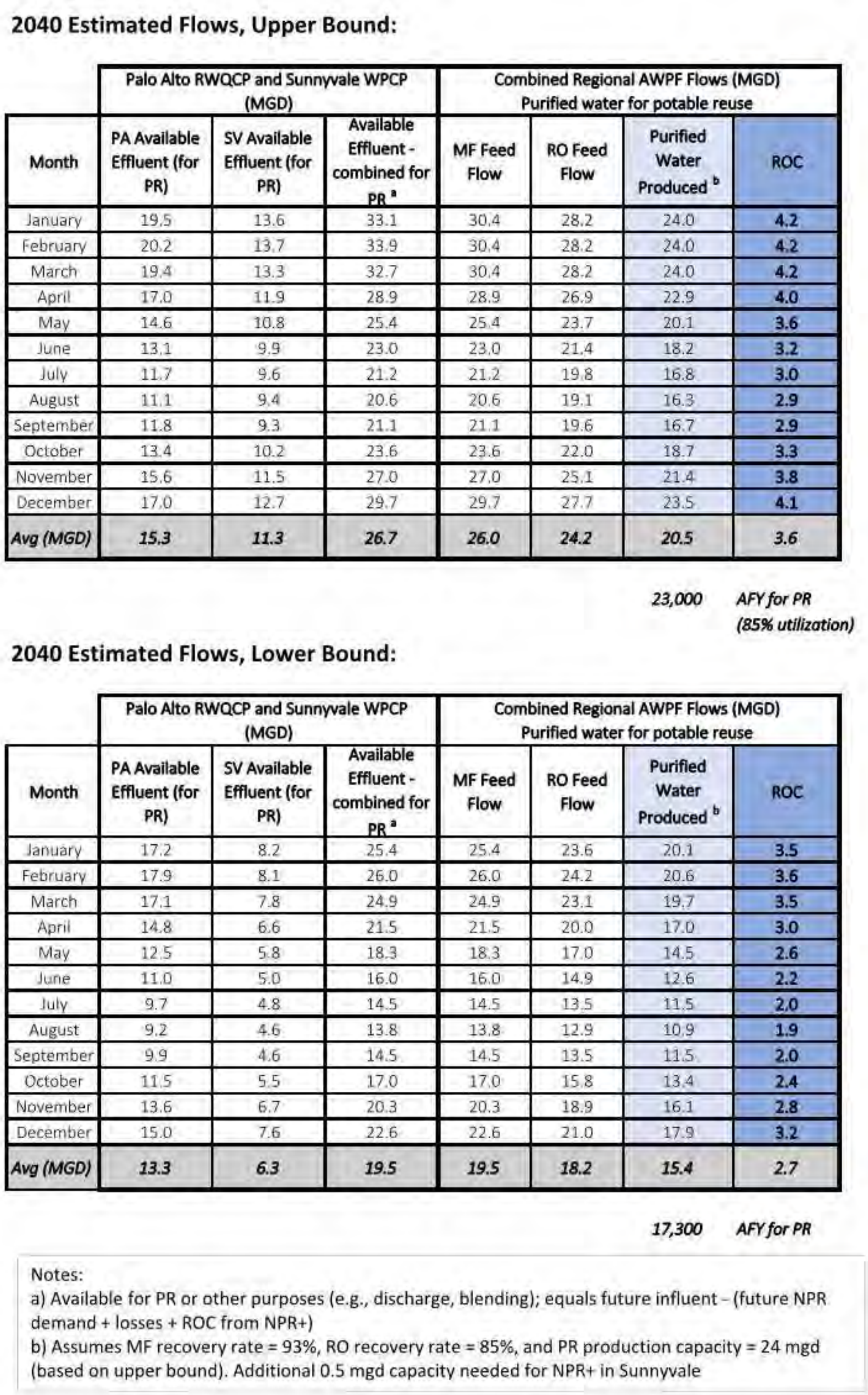
2040 Estimated Flows, Lower Bound:

	Sunnyvale WPCP Flows (MGD)			Sunnyvale AWPF flows needed for NPR+ (MGD)			Sunnyvale Regional AWPF Flows (MGD) Purified water for potable reuse				
Month	**Future Influent**	**Future NPR Demand**	**Losses**	**Purified water needed for blending [a]**	**ROC from NPR+**	**Available Effluent (for PR) [b]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**ROC**	**Total purified water produced**
January	12.8	0.6	4.0	0.3	0.1	8.2	8.2	7.6	6.4	1.1	6.7
February	12.9	0.7	4.0	0.4	0.1	8.1	8.1	7.6	6.4	1.1	6.8
March	13.0	1.1	4.0	0.5	0.1	7.8	7.8	7.3	6.2	1.1	6.7
April	12.3	1.5	4.0	0.7	0.1	6.6	6.6	6.2	5.3	0.9	6.0
May	11.9	2.0	4.0	1.0	0.2	5.8	5.8	5.4	4.5	0.8	5.5
June	11.7	2.5	4.0	1.2	0.2	5.0	5.0	4.6	3.9	0.7	5.1
July	11.3	2.4	4.0	1.2	0.2	4.8	4.8	4.4	3.8	0.7	4.9
August	11.3	2.5	4.0	1.2	0.2	4.6	4.6	4.3	3.6	0.6	4.9
September	11.1	2.3	4.0	1.1	0.2	4.6	4.6	4.2	3.6	0.6	4.7
October	11.1	1.5	4.0	0.7	0.1	5.5	5.5	5.1	4.3	0.8	5.1
November	11.3	0.6	4.0	0.3	0.0	6.7	6.7	6.2	5.3	0.9	5.6
December	12.0	0.3	4.0	0.2	0.0	7.6	7.6	7.1	6.0	1.1	6.2
Avg (MGD)	***11.9***	***1.5***	***4.0***	***0.7***	***0.1***	***6.3***	***6.3***	***5.8***	***4.9***	***0.9***	***5.6***

800 *AFY for NPR+* *5,500* *AFY for PR* *6,400* *AFY*

Notes:
a) To achieve target TDS of 500 mg/L for NPR+
b) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand + losses + ROC from NPR+)
c) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 10 mgd (based on upper bound)
d) Drives overall production capacity (10.5 mgd)

Table B-3. Combined Palo Alto/Sunnyvale Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2040 Estimated Flows, Upper Bound:

Month	Palo Alto RWQCP and Sunnyvale WPCP (MGD)			Combined Regional AWPF Flows (MGD) Purified water for potable reuse			
	PA Available Effluent (for PR)	SV Available Effluent (for PR)	Available Effluent - combined for PR [a]	MF Feed Flow	RO Feed Flow	Purified Water Produced [b]	ROC
January	19.5	13.6	33.1	30.4	28.2	24.0	**4.2**
February	20.2	13.7	33.9	30.4	28.2	24.0	**4.2**
March	19.4	13.3	32.7	30.4	28.2	24.0	**4.2**
April	17.0	11.9	28.9	28.9	26.9	22.9	**4.0**
May	14.6	10.8	25.4	25.4	23.7	20.1	**3.6**
June	13.1	9.9	23.0	23.0	21.4	18.2	**3.2**
July	11.7	9.6	21.2	21.2	19.8	16.8	**3.0**
August	11.1	9.4	20.6	20.6	19.1	16.3	**2.9**
September	11.8	9.3	21.1	21.1	19.6	16.7	**2.9**
October	13.4	10.2	23.6	23.6	22.0	18.7	**3.3**
November	15.6	11.5	27.0	27.0	25.1	21.4	**3.8**
December	17.0	12.7	29.7	29.7	27.7	23.5	**4.1**
Avg (MGD)	***15.3***	***11.3***	***26.7***	***26.0***	***24.2***	***20.5***	***3.6***

23,000 ***AFY for PR***
(85% utilization)

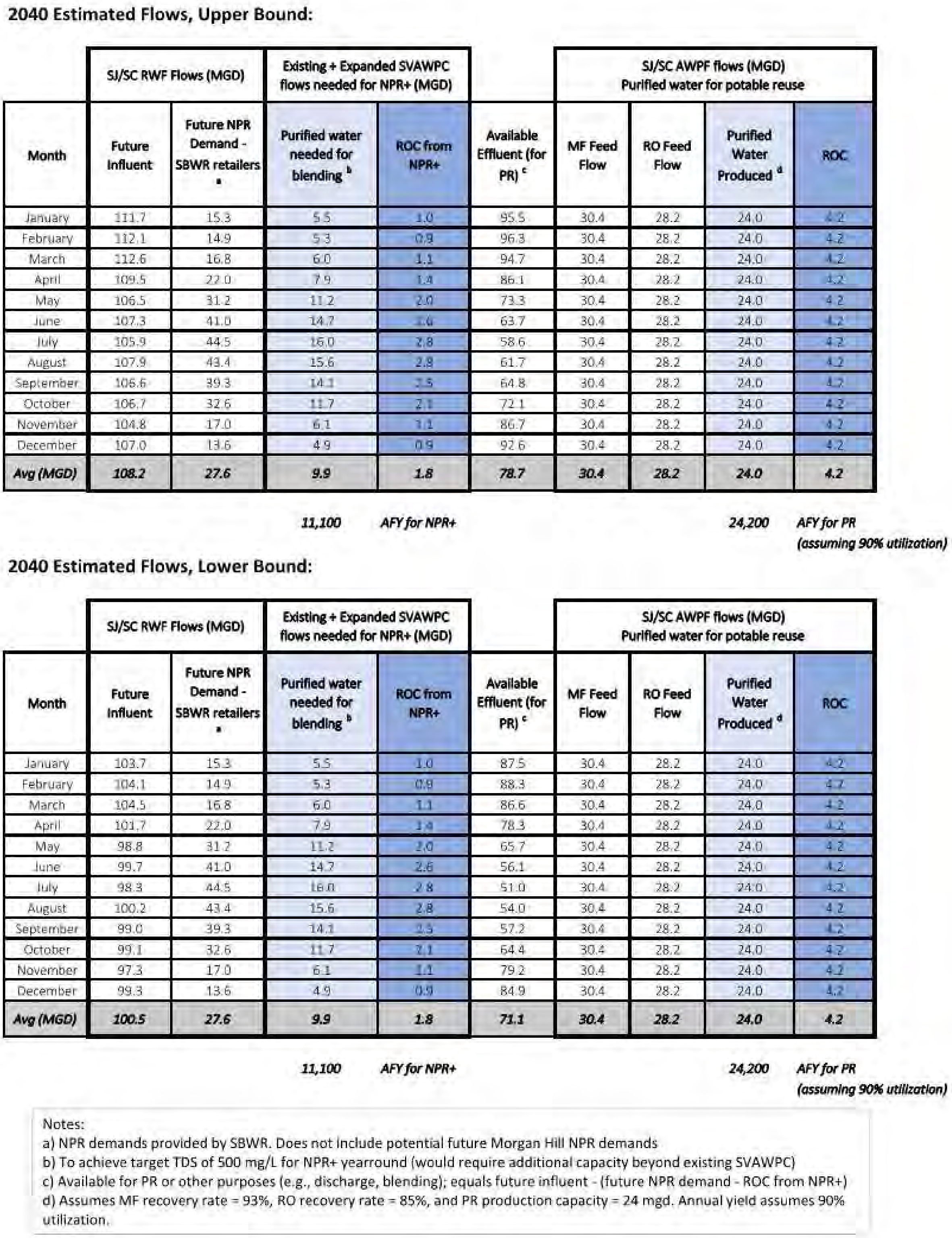
2040 Estimated Flows, Lower Bound:

Month	Palo Alto RWQCP and Sunnyvale WPCP (MGD)			Combined Regional AWPF Flows (MGD) Purified water for potable reuse			
	PA Available Effluent (for PR)	SV Available Effluent (for PR)	Available Effluent - combined for PR [a]	MF Feed Flow	RO Feed Flow	Purified Water Produced [b]	ROC
January	17.2	8.2	25.4	25.4	23.6	20.1	**3.5**
February	17.9	8.1	26.0	26.0	24.2	20.6	**3.6**
March	17.1	7.8	24.9	24.9	23.1	19.7	**3.5**
April	14.8	6.6	21.5	21.5	20.0	17.0	**3.0**
May	12.5	5.8	18.3	18.3	17.0	14.5	**2.6**
June	11.0	5.0	16.0	16.0	14.9	12.6	**2.2**
July	9.7	4.8	14.5	14.5	13.5	11.5	**2.0**
August	9.2	4.6	13.8	13.8	12.9	10.9	**1.9**
September	9.9	4.6	14.5	14.5	13.5	11.5	**2.0**
October	11.5	5.5	17.0	17.0	15.8	13.4	**2.4**
November	13.6	6.7	20.3	20.3	18.9	16.1	**2.8**
December	15.0	7.6	22.6	22.6	21.0	17.9	**3.2**
Avg (MGD)	***13.3***	***6.3***	***19.5***	***19.5***	***18.2***	***15.4***	***2.7***

17,300 ***AFY for PR***

Notes:
a) Available for PR or other purposes (e.g., discharge, blending); equals future influent – (future NPR demand + losses + ROC from NPR+)
b) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 24 mgd (based on upper bound). Additional 0.5 mgd capacity needed for NPR+ in Sunnyvale

Table B-4. San Jose/Santa Clara Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2040 Estimated Flows, Upper Bound:

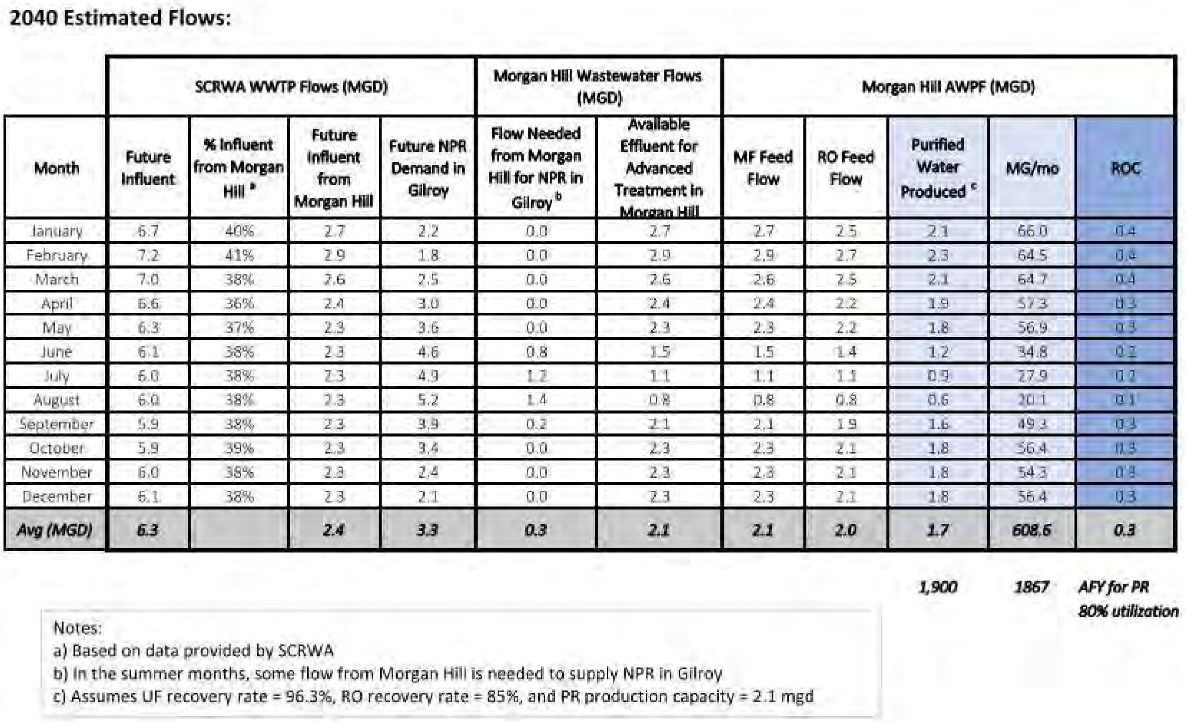
	SJ/SC RWF Flows (MGD)		Existing + Expanded SVAWPC flows needed for NPR+ (MGD)			SJ/SC AWPF flows (MGD) Purified water for potable reuse			
Month	**Future Influent**	**Future NPR Demand - SBWR retailers [a]**	**Purified water needed for blending [b]**	**ROC from NPR+**	**Available Effluent (for PR) [c]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [d]**	**ROC**
January	111.7	15.3	5.5	1.0	95.5	30.4	28.2	24.0	4.2
February	112.1	14.9	5.3	0.9	96.3	30.4	28.2	24.0	4.2
March	112.6	16.8	6.0	1.1	94.7	30.4	28.2	24.0	4.2
April	109.5	22.0	7.9	1.4	86.1	30.4	28.2	24.0	4.2
May	106.5	31.2	11.2	2.0	73.3	30.4	28.2	24.0	4.2
June	107.3	41.0	14.7	2.6	63.7	30.4	28.2	24.0	4.2
July	105.9	44.5	16.0	2.8	58.6	30.4	28.2	24.0	4.2
August	107.9	43.4	15.6	2.8	61.7	30.4	28.2	24.0	4.2
September	106.6	39.3	14.1	2.5	64.8	30.4	28.2	24.0	4.2
October	106.7	32.6	11.7	2.1	72.1	30.4	28.2	24.0	4.2
November	104.8	17.0	6.1	1.1	86.7	30.4	28.2	24.0	4.2
December	107.0	13.6	4.9	0.9	92.6	30.4	28.2	24.0	4.2
Avg (MGD)	***108.2***	***27.6***	***9.9***	***1.8***	***78.7***	***30.4***	***28.2***	***24.0***	***4.2***
			11,100	***AFY for NPR+***				***24,200***	***AFY for PR (assuming 90% utilization)***

2040 Estimated Flows, Lower Bound:

	SJ/SC RWF Flows (MGD)		Existing + Expanded SVAWPC flows needed for NPR+ (MGD)			SJ/SC AWPF flows (MGD) Purified water for potable reuse			
Month	**Future Influent**	**Future NPR Demand - SBWR retailers [a]**	**Purified water needed for blending [b]**	**ROC from NPR+**	**Available Effluent (for PR) [c]**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [d]**	**ROC**
January	103.7	15.3	5.5	1.0	87.5	30.4	28.2	24.0	4.2
February	104.1	14.9	5.3	0.9	88.3	30.4	28.2	24.0	4.2
March	104.5	16.8	6.0	1.1	86.6	30.4	28.2	24.0	4.2
April	101.7	22.0	7.9	1.4	78.3	30.4	28.2	24.0	4.2
May	98.8	31.2	11.2	2.0	65.7	30.4	28.2	24.0	4.2
June	99.7	41.0	14.7	2.6	56.1	30.4	28.2	24.0	4.2
July	98.3	44.5	16.0	2.8	51.0	30.4	28.2	24.0	4.2
August	100.2	43.4	15.6	2.8	54.0	30.4	28.2	24.0	4.2
September	99.0	39.3	14.1	2.5	57.2	30.4	28.2	24.0	4.2
October	99.1	32.6	11.7	2.1	64.4	30.4	28.2	24.0	4.2
November	97.3	17.0	6.1	1.1	79.2	30.4	28.2	24.0	4.2
December	99.3	13.6	4.9	0.9	84.9	30.4	28.2	24.0	4.2
Avg (MGD)	***100.5***	***27.6***	***9.9***	***1.8***	***71.1***	***30.4***	***28.2***	***24.0***	***4.2***
			11,100	***AFY for NPR+***				***24,200***	***AFY for PR (assuming 90% utilization)***

Notes:
a) NPR demands provided by SBWR. Does not include potential future Morgan Hill NPR demands
b) To achieve target TDS of 500 mg/L for NPR+ yearround (would require additional capacity beyond existing SVAWPC)
c) Available for PR or other purposes (e.g., discharge, blending); equals future influent - (future NPR demand - ROC from NPR+)
d) Assumes MF recovery rate = 93%, RO recovery rate = 85%, and PR production capacity = 24 mgd. Annual yield assumes 90% utilization.

Table B-5. Morgan Hill Monthly Flow Calculations for Determining AWPF Capacity and Annual Yield



2040 Estimated Flows:

	SCRWA WWTP Flows (MGD)				Morgan Hill Wastewater Flows (MGD)		Morgan Hill AWPF (MGD)				
Month	**Future Influent**	**% Influent from Morgan Hill [a]**	**Future Influent from Morgan Hill**	**Future NPR Demand in Gilroy**	**Flow Needed from Morgan Hill for NPR in Gilroy [b]**	**Available Effluent for Advanced Treatment in Morgan Hill**	**MF Feed Flow**	**RO Feed Flow**	**Purified Water Produced [c]**	**MG/mo**	**ROC**
January	6.7	40%	2.7	2.2	0.0	2.7	2.7	2.5	2.1	66.0	0.4
February	7.2	41%	2.9	1.8	0.0	2.9	2.9	2.7	2.3	64.5	0.4
March	7.0	38%	2.6	2.5	0.0	2.6	2.6	2.5	2.1	64.7	0.4
April	6.6	36%	2.4	3.0	0.0	2.4	2.4	2.2	1.9	57.3	0.3
May	6.3	37%	2.3	3.6	0.0	2.3	2.3	2.2	1.8	56.9	0.3
June	6.1	38%	2.3	4.6	0.8	1.5	1.5	1.4	1.2	34.8	0.2
July	6.0	38%	2.3	4.9	1.2	1.1	1.1	1.1	0.9	27.9	0.2
August	6.0	38%	2.3	5.2	1.4	0.8	0.8	0.8	0.6	20.1	0.1
September	5.9	38%	2.3	3.9	0.2	2.1	2.1	1.9	1.6	49.3	0.3
October	5.9	39%	2.3	3.4	0.0	2.3	2.3	2.1	1.8	56.4	0.3
November	6.0	38%	2.3	2.4	0.0	2.3	2.3	2.1	1.8	54.3	0.3
December	6.1	38%	2.3	2.1	0.0	2.3	2.3	2.1	1.8	56.4	0.3
Avg (MGD)	***6.3***		***2.4***	***3.3***	***0.3***	***2.1***	***2.1***	***2.0***	***1.7***	***608.6***	***0.3***
									1,900	***1867***	***AFY for PR***
											80% utilization

Notes:
a) Based on data provided by SCRWA
b) In the summer months, some flow from Morgan Hill is needed to supply NPR in Gilroy
c) Assumes UF recovery rate = 96.3%, RO recovery rate = 85%, and PR production capacity = 2.1 mgd

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Attachment C: AWPF Sizing Calculations

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Table C-1. Determination of Portfolio 1 AWPF Capacity and Utilization, SJ/SC AWPF

2040 Flows

LEGEND

🟩	Recommended capacity (to achieve 24,000 AFY @ 90% utilization)
🟧	Capacity that would maximize potable reuse

Notes:

1. Values shown below represent purified water for potable reuse (NPR+ considered separately).
2. SJ/SC RWF has enough effluent to produce more purified water. Assume 90% utilization for sizing purposes and select capacity based on meeting 24,000 AFY PR goal.

Purified Water Production Capacity (for PR) =				20.0		21.0		22.0		23.0		24.0		40.0		60.0		76.1		80.0		100.0	
Month		Available Effluent for PR - San Jose (mgd)	Total Available Effluent for PR (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January		95.5	95.5	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	95.5	75.5	95.5	75.5	95.5	75.5
February		96.3	96.3	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	96.3	76.1	96.3	76.1	96.3	76.1
March		94.7	94.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	94.7	74.9	94.7	74.9	94.7	74.9
April		86.1	86.1	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	86.1	68.1	86.1	68.1	86.1	68.1
May		73.3	73.3	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	73.3	58.0	73.3	58.0	73.3	58.0	73.3	58.0
June		63.7	63.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	63.7	50.4	63.7	50.4	63.7	50.4	63.7	50.4
July		58.6	58.6	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	58.6	46.3	58.6	46.3	58.6	46.3	58.6	46.3
August		61.7	61.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	61.7	48.8	61.7	48.8	61.7	48.8	61.7	48.8
September		64.8	64.8	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	64.8	51.2	64.8	51.2	64.8	51.2	64.8	51.2
October		72.1	72.1	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	72.1	57.0	72.1	57.0	72.1	57.0	72.1	57.0
November		86.7	86.7	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	86.7	68.6	86.7	68.6	86.7	68.6
December		92.6	92.6	25.3	20.0	26.6	21.0	27.8	22.0	29.1	23.0	30.4	24.0	50.6	40.0	75.9	60.0	92.6	73.2	92.6	73.2	92.6	73.2
Average Annual (mgd):					20.0		21.0		22.0		23.0		24.0		40.0		55.9		62.2		62.2		62.2
Actual production (AFY):					22,396		23,516		24,636		25,756		26,876		44,793		62,653		69,710		69,710		69,710
Utilization %:					100%		100%		100%		100%		100%		100%		93%		82%		78%		62%
Incrementatal utilization %:							100%		100%		100%		100%		100%		80%		39%		0%		0%
Production @90% utilization (AFY):					**20,157**		**21,165**		**22,172**		**23,180**		**24,188**		**40,314**		**56,388**		**62,739**		**62,739**		**62,739**

Table C-2. Determination of Portfolio 2 AWPF Capacity and Utilization, Combined Regional Palo Alto/Sunnyvale AWPF

2040 Flows (upper bound)

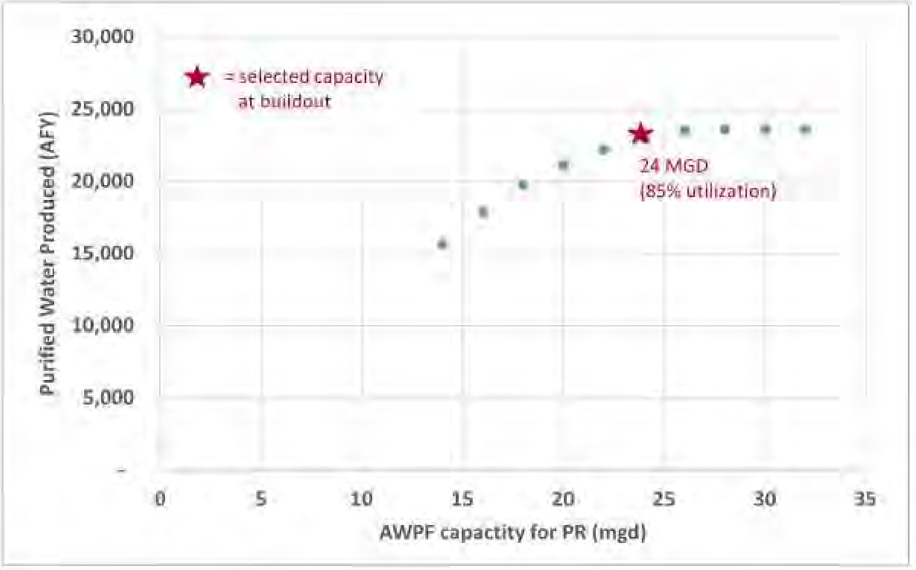
LEGEND

🟩 Recommended capacity
🟧 Capacity that would maximize potable reuse

Notes:

1. Combined regional AWPF receives feed flow from both Palo Alto and Sunnyvale (though could be located in either city).
2. Values shown below represent purified water for potable reuse (additional capacity would be needed for NPR+ in Sunnyvale).

			Production Capacity (for PR) =	16.0		18.0		20.0		22.0		24.0		26.0		26.8		28.0	
Month	Available Effluent for PR - Palo Alto (mgd)	Available Effluent for PR - Sunnyvale (mgd)	Total Available Effluent for PR (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	19.5	13.6	33.1	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.9	26.0	33.1	26.2	33.1	26.2
February	20.2	13.7	33.9	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.9	26.0	33.9	26.8	33.9	26.8
March	19.4	13.3	32.7	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	30.4	24.0	32.7	25.9	32.7	25.9	32.7	25.9
April	17.0	11.9	28.9	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	28.9	22.9	28.9	22.9	28.9	22.9	28.9	22.9
May	14.6	10.8	25.4	20.2	16.0	22.8	18.0	25.3	20.0	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1
June	13.1	9.9	23.0	20.2	16.0	22.8	18.0	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2	23.0	18.2
July	11.7	9.6	21.2	20.2	16.0	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8	21.2	16.8
August	11.1	9.4	20.6	20.2	16.0	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3	20.6	16.3
September	11.8	9.3	21.1	20.2	16.0	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7	21.1	16.7
October	13.4	10.2	23.6	20.2	16.0	22.8	18.0	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7	23.6	18.7
November	15.6	11.5	27.0	20.2	16.0	22.8	18.0	25.3	20.0	27.0	21.4	27.0	21.4	27.0	21.4	27.0	21.4	27.0	21.4
December	17.0	12.7	29.7	20.2	16.0	22.8	18.0	25.3	20.0	27.8	22.0	29.7	23.5	29.7	23.5	29.7	23.5	29.7	23.5
			Average annual (mgd):		16.0		17.6		18.9		19.8		20.5		21.0		21.1		21.1
			Actual production (AFY):		17,917		19,752		21,134		22,197		22,972		23,513		23,597		23,597
			Utilization %:		100%		98%		94%		90%		85%		81%		79%		75%
			Incrementatal utilization %:		100%		82%		62%		47%		35%		24%		9%		0%



2040 Flows (lower bound)

			Production Capacity (for PR) =	16.0		18.0		20.0		20.6		22.0		24.0		26.0		28.0	
Month	Available Effluent for PR - Palo Alto (mgd)	Available Effluent for PR - Sunnyvale (mgd)	Total Available Effluent for PR (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	17.2	8.2	25.4	20.2	16.0	22.8	18.0	25.3	20.0	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1	25.4	20.1
February	17.9	8.1	26.0	20.2	16.0	22.8	18.0	25.3	20.0	26.0	20.6	26.0	20.6	26.0	20.6	26.0	20.6	26.0	20.6
March	17.1	7.8	24.9	20.2	16.0	22.8	18.0	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7	24.9	19.7
April	14.8	6.6	21.5	20.2	16.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0	21.5	17.0
May	12.5	5.8	18.3	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5	18.3	14.5
June	11.0	5.0	16.0	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6	16.0	12.6
July	9.7	4.8	14.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5
August	9.2	4.6	13.8	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9	13.8	10.9
September	9.9	4.6	14.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5	14.5	11.5
October	11.5	5.5	17.0	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4
November	13.6	6.7	20.3	20.2	16.0	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1	20.3	16.1
December	15.0	7.6	22.6	20.2	16.0	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9	22.6	17.9
			Average annual (mgd):		14.2		14.9		15.4		15.4		15.4		15.4		15.4		15.4
			Actual production (AFY):		15,886		16,712		17,234		17,291		17,291		17,291		17,291		17,291
			Utilization %:		89%		83%		77%		75%		70%		64%		59%		55%
			Incrementatal utilization %:		52%		37%		23%		8%		0%		0%		0%		0%

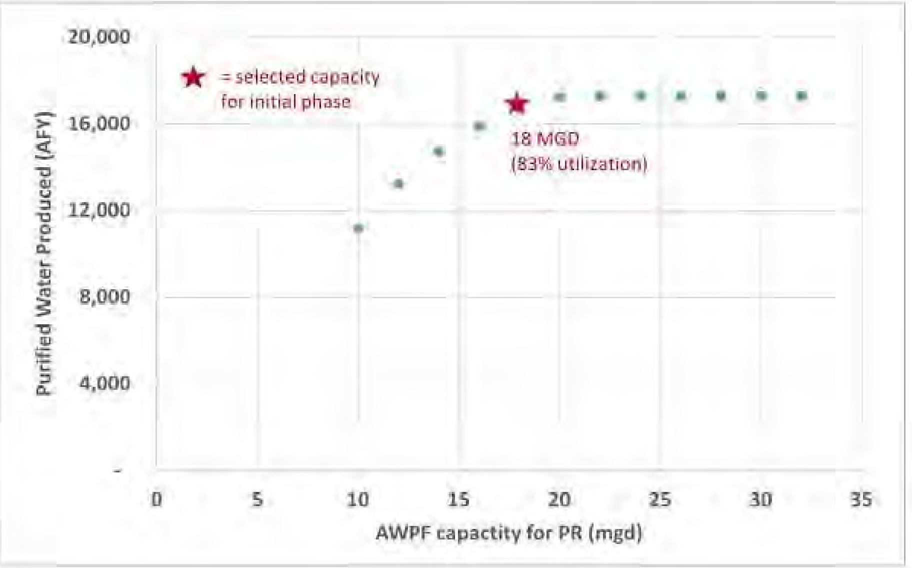


Table C-3. Determination of Portfolio 4 AWPF Capacity and Utilization, Separate Regional AWPF in Palo Alto

2040 Flows (upper bound)

LEGEND

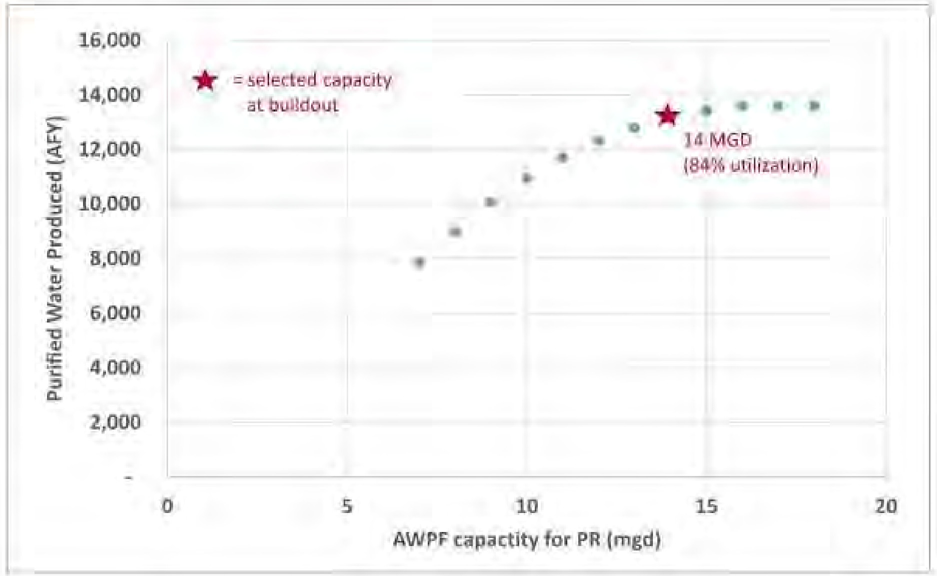
🟩 Recommended capacity

🟧 Capacity that would maximize potable

Notes:

1. Regional AWPF receives feed flow from Palo Alto (a separate regional facility is located in Sunnyvale).
2. Values shown below represent purified water for potable reuse. Assumes a separate AWPF for NPR+ in Palo Alto.

Production Capacity (for PR) =		10.0		11.0		12.0		13.0		14.0		15.0		16.0		17.0	
Month	Available effluent for PR - Palo Alto (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	19.5	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	19.5	15.4	19.5	15.4
February	20.2	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	20.2	16.0	20.2	16.0
March	19.4	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.7	14.0	19.0	15.0	19.4	15.3	19.4	15.3
April	17.0	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.0	13.5	17.0	13.5	17.0	13.5	17.0	13.5
May	14.6	12.7	10.0	13.9	11.0	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6	14.6	11.6
June	13.1	12.7	10.0	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3	13.1	10.3
July	11.7	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2	11.7	9.2
August	11.1	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8	11.1	8.8
September	11.8	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3	11.8	9.3
October	13.4	12.7	10.0	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6	13.4	10.6
November	15.6	12.7	10.0	13.9	11.0	15.2	12.0	15.6	12.3	15.6	12.3	15.6	12.3	15.6	12.3	15.6	12.3
December	17.0	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.0	13.4	17.0	13.4	17.0	13.4	17.0	13.4
Average annual (mgd):			9.8		10.4		11.0		11.4		11.7		12.0		12.1		12.1
Actual production (AFY):			10,949		11,688		12,299		12,789		13,150		13,426		13,582		13,582
Utilization %:			98%		95%		92%		88%		84%		80%		76%		71%
Incrementatal utilization %:			79%		66%		54%		44%		32%		25%		14%		0%



2040 Flows (lower bound)

Production Capacity (for PR) =		10.0		11.0		12.0		13.0		14.1		15.0		16.0		17.0	
Month	Available effluent for PR - Palo Alto (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	17.2	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.2	13.6	17.2	13.6	17.2	13.6	17.2	13.6
February	17.9	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.8	14.1	17.9	14.1	17.9	14.1	17.9	14.1
March	17.1	12.7	10.0	13.9	11.0	15.2	12.0	16.4	13.0	17.1	13.5	17.1	13.5	17.1	13.5	17.1	13.5
April	14.8	12.7	10.0	13.9	11.0	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7	14.8	11.7
May	12.5	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9	12.5	9.9
June	11.0	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7	11.0	8.7
July	9.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7	9.7	7.7
August	9.2	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3	9.2	7.3
September	9.9	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8
October	11.5	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1	11.5	9.1
November	13.6	12.7	10.0	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8	13.6	10.8
December	15.0	12.7	10.0	13.9	11.0	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8	15.0	11.8
Average annual (mgd):			9.2		9.7		10.1		10.3		10.5		10.5		10.5		10.5
Actual production (AFY):			10,313		10,847		11,269		11,546		11,746		11,750		11,750		11,750
Utilization %:			92%		88%		84%		79%		74%		70%		66%		62%
Incrementatal utilization %:			58%		48%		38%		25%		16%		0%		0%		0%

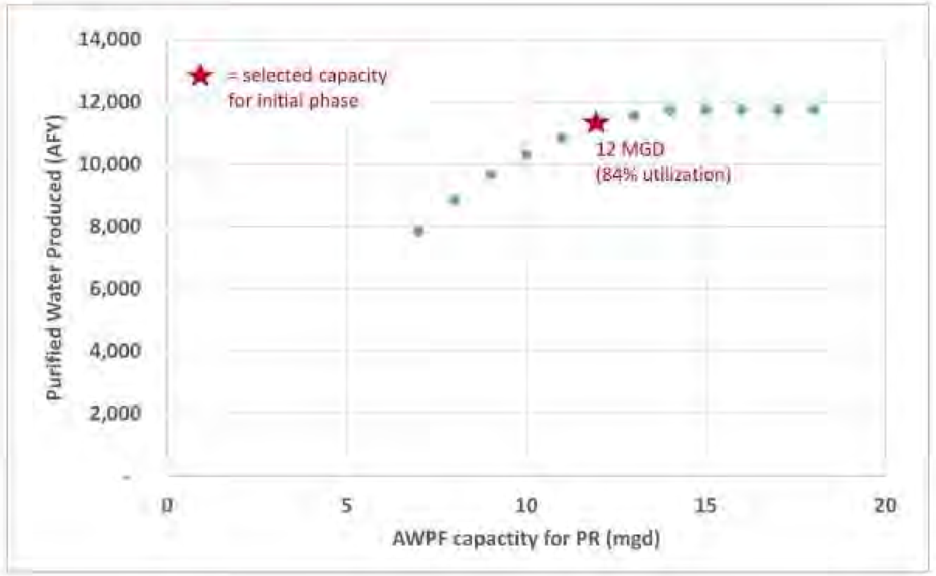


Table C-4. Determination of Portfolio 4 AWPF Capacity and Utilization, Separate Regional AWPF in Sunnyvale

2040 Flows (upper bound)

LEGEND

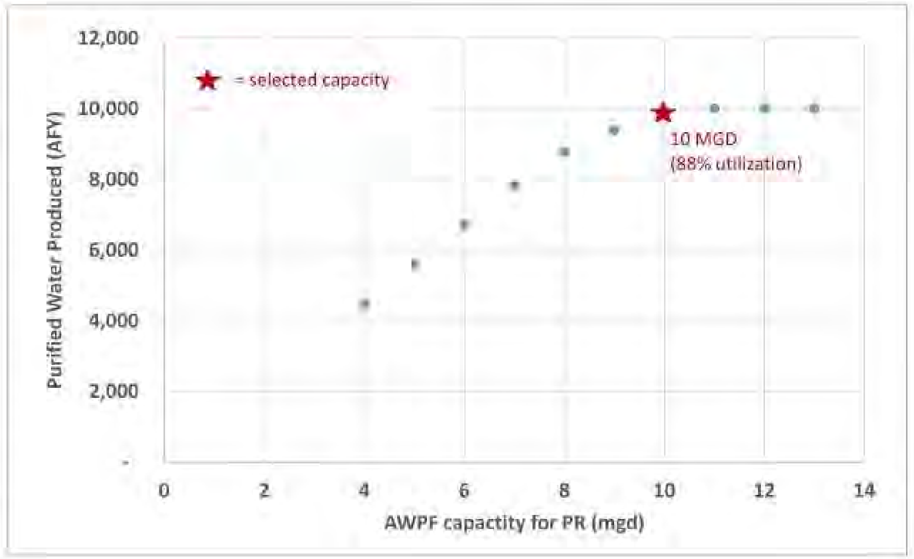
🟩 Recommended capacity

🟧 Capacity that would maximize potable reus

Notes:

1. Regional AWPF receives feed flow from Sunnyvale (a separate regional facility is located in Palo Alto).
2. Values shown below represent purified water for potable reuse (additional capacity would be needed for NPR+ in Sunnyvale).

Production Capacity (for PR) =		5.0		6.0		7.0		8.0		9.0		10.0		10.8		12.0	
Month	Available Effluent for PR Sunnyvale (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)
January	13.6	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.6	10.8	13.6	10.8
February	13.7	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.7	10.8	13.7	10.8
March	13.3	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	13.3	10.6	13.3	10.6
April	11.9	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	11.9	9.4	11.9	9.4	11.9	9.4
May	10.8	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	10.8	8.5	10.8	8.5	10.8	8.5	10.8	8.5
June	9.9	6.3	5.0	7.6	6.0	8.9	7.0	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8	9.9	7.8
July	9.6	6.3	5.0	7.6	6.0	8.9	7.0	9.6	7.6	9.6	7.6	9.6	7.6	9.6	7.6	9.6	7.6
August	9.4	6.3	5.0	7.6	6.0	8.9	7.0	9.4	7.4	9.4	7.4	9.4	7.4	9.4	7.4	9.4	7.4
September	9.3	6.3	5.0	7.6	6.0	8.9	7.0	9.3	7.3	9.3	7.3	9.3	7.3	9.3	7.3	9.3	7.3
October	10.2	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	10.2	8.1	10.2	8.1	10.2	8.1	10.2	8.1
November	11.5	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	11.5	9.1	11.5	9.1	11.5	9.1
December	12.7	6.3	5.0	7.6	6.0	8.9	7.0	10.1	8.0	11.4	9.0	12.7	10.0	12.7	10.1	12.7	10.1
Average annual (mgd):			5.0		6.0		7.0		7.8		8.4		8.8		8.9		8.9
Actual production (AFY):			5,599		6,719		7,839		8,788		9,402		9,815		10,015		10,015
Utilization %:			100%		100%		100%		98%		93%		88%		83%		75%
Incrementatal utilization %:			100%		100%		100%		85%		55%		37%		22%		0%



2040 Flows (lower bound)

Production Capacity (for PR) =		5.0		6.0		6.4		8.0		9.0		10.0		11.0		12.0	
Month	Available Effluent for PR Sunnyvale (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)	MF Feed flow (mgd)	Purified Water produced (mgd)
January	8.2	6.3	5.0	7.6	6.0	8.1	6.4	8.2	6.4	8.2	6.4	8.2	6.4	8.2	6.4	8.2	6.4
February	8.1	6.3	5.0	7.6	6.0	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4	8.1	6.4
March	7.8	6.3	5.0	7.6	6.0	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2	7.8	6.2
April	6.6	6.3	5.0	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3	6.6	5.3
May	5.8	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5	5.8	4.5
June	5.0	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9	5.0	3.9
July	4.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8	4.8	3.8
August	4.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6
September	4.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6	4.6	3.6
October	5.5	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3	5.5	4.3
November	6.7	6.3	5.0	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3	6.7	5.3
December	7.6	6.3	5.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0	7.6	6.0
Average annual (mgd):			4.5		4.9		4.9		4.9		4.9		4.9		4.9		4.9
Actual production (AFY):			5,018		5,438		5,540		5,540		5,540		5,540		5,540		5,540
Utilization %:			90%		81%		77%		62%		55%		49%		45%		41%
Incrementatal utilization %:			57%		38%		21%		0%		0%		0%		0%		0%

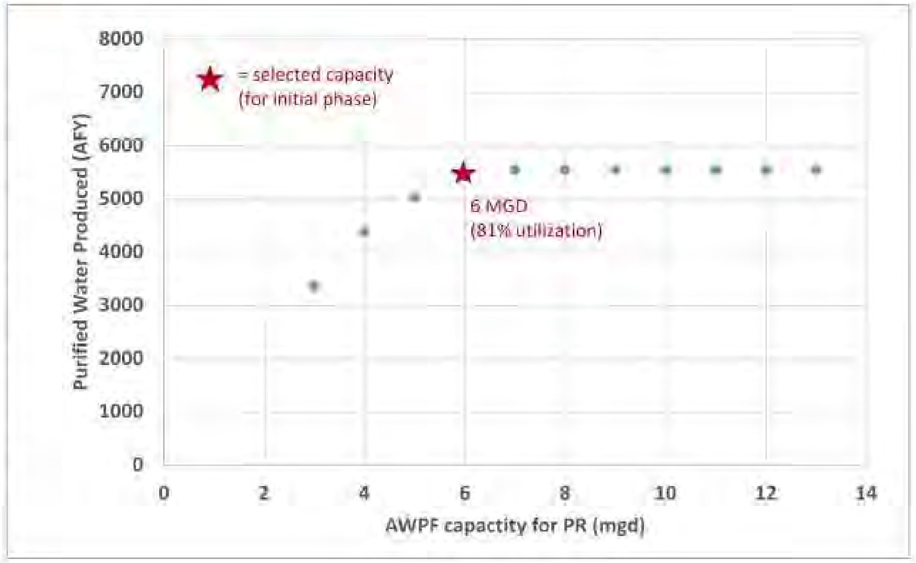


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Table C-5. Determination of Morgan Hill AWPF Capacity and Utilization

2040 Flows

LEGEND

🟩 Recommended capacity

🟧 Capacity that would maximize potable reuse

Notes:

1. Available effluent based on Morgan Hill's contribution to SCRWA WWTP, minus flow needed to meet NPR demands in Gilroy.

		1.50		1.60		1.70		1.8		1.9		2.0		2.1		2.2		2.3		2.4		2.5	
Month	Available Effluent for PR - Morgan Hill (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)	MF feed flow (mgd)	Purified water produced (mgd)
January	2.7	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.7	2.2	2.7	2.2	2.7	2.2	2.7	2.2
February	2.9	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.7	2.2	2.8	2.3	2.9	2.4	2.9	2.4
March	2.6	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.6	2.1	2.6	2.2	2.6	2.2	2.6	2.2	2.6	2.2
April	2.4	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0	2.4	2.0
May	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
June	1.5	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2
July	1.1	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9	1.1	0.9
August	0.8	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7
September	2.1	1.8	1.5	2.0	1.6	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7	2.1	1.7
October	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
November	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
December	2.3	1.8	1.5	2.0	1.6	2.1	1.7	2.2	1.8	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9	2.3	1.9
Average Annual (mgd):			1.4		1.4		1.5		1.6		1.6		1.7		1.7		1.7		1.7		1.7		1.7
Actual production (AFY):			1,519		1,603		1,687		1,762		1,830		1,865		1,893		1,917		1,926		1,933		1,933
Utilization %:			90%		89%		89%		87%		86%		83%		80%		78%		75%		72%		69%
Incrementatal utilization %:					75%		75%		67%		61%		31%		25%		21%		8%		7%		0%

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Appendix A-3: Design Criteria

Table of Contents

A.1 North County Advanced Water Purification Facilities (AWPF) 4
- A.1.1 Portfolios Evaluated 4
- A.1.2 Water Quality 5
- A.1.3 Influent Pump Station/Equalization Basin 6
- A.1.4 Ozone and Biologically Activated Carbon 6
- A.1.5 Ultrafiltration System 7
- A.1.6 Reverse Osmosis System 9
- A.1.7 Decarbonation/Air Stripping System 12
- A.1.8 Advanced Oxidation Process System 13
- A.1.9 Post Treatment Stabilization Process 14
- A.1.10 Chlorine Disinfection Process 14
- A.1.11 Purified Water Storage Clearwell 15
- A.1.12 UF Backwash Disposal 16

A.2 Morgan Hill Satellite and AWPF Design Criteria 17
- A.2.1 Influent Pump Station 17
- A.2.2 Headworks 18
- A.2.3 Equalization Basin and Intermediate Pump Station 19
- A.2.4 Membrane Bioreactor System 19
- A.2.5 Blowers and Mixers 20
- A.2.6 RAS/WAS Pump Systems 21
- A.2.7 RO System 21
- A.2.8 Decarbonation System 24
- A.2.9 Advanced Oxidation Process (UV/AOP) System 24
- A.2.10 Post-Treatment Stabilization Process 25

List of Tables

Table A-1. North County AWPFs by Portfolio....4

Table A-2. Estimate Feed Water Quality....5

Table A-3. Influent Pump Station Design Criteria....6

Table A-4. Ozone and BAC Design Criteria for Portfolio 1b....7

Table A-5. Strainer Design Criteria....8

Table A-6. Pressure UF System Design Criteria....8

Table A-7. UF/RO Interprocess Tank Design Criteria....9

Table A-8. RO Transfer Pump Design Criteria....9

Table A-9. RO Cartridge Filter Design Criteria....10

Table A-10. RO Feed Pumps Design Criteria....10

Table A-11. RO System Design Criteria....11

Table A-12. Decarbonator/Air Stripping Design Criteria....12

Table A-13. Advanced Oxidation Process Design Criteria....13

Table A-14. Post-Treatment Stabilization and Chemical Requirements[a]....14

Table A-15. Chlorine Disinfection Design Criteria for Portfolio 1c and 1d[a]....15

Table A-16. Purified Water Storage Clearwell Design Criteria....16

Table A-17. Waste Side-Stream Flows....16

Table A-18. Waste Equalization Design Criteria....17

Table A-19. Influent Pump Station Design Criteria....17

Table A-20. Headworks Design Criteria....18

Table A-21. Equalization Basin Design Criteria....19

Table A-22. Intermediate Pump Station Design Criteria....19

Table A-23. Bioreactor System Design Criteria....20

Table A-24. Blowers and Mixers Design Criteria....20

Table A-25. RAS and WAS Pumps Design Criteria....21

Table A-26. RO Interprocess Tank Design Criteria....21

Table A-27. RO Transfer Pump Design Criteria....22

Table A-28. RO Cartridge Filter Design Criteria....22

Table A-29. RO Feed Pump Design Criteria....22

Table A-30. RO System Design Criteria....23

Table A-31. RO CIP System....23

Table A-32. Decarbonation Criteria....24

Table A-33. UV/AOP Criteria 25

Table A-34. Post-Treatment Stabilization and Chemical Requirements 25

Appendix A-3

Design Criteria

A.1 North County Advanced Water Purification Facilities (AWPF)

A.1.1 Portfolios Evaluated

Table A-1 summarizes the portfolios evaluated as part of the Countywide Water Reuse Master Plan (CoRe Plan) preliminary level design of AWPFs.

Table A-1. North County AWPFs by Portfolio

Portfolio number	Description	Source flow	AWPF location	Design capacity and treatment process
1a	Ground Water Reuse (GWR) in Los Gatos Recharge Ponds	San José/Santa Clara (SJ/SC) Regional Wastewater Facility (RWF)	San José	24 million gallons per day (mgd) plant with full advanced treatment (FAT) process
1b	Raw Water Augmentation (RWA) at Penitencia Water Treatment Plant (WTP)	SJ/SC RWF	San José	24-mgd plant with FAT process plus ozone-biological activated carbon (O_3-BAC)
1c	Treated Water Augmentation (TWA) with direct delivery to Santa Clara, San José, San Jose Water, and Valley Water	SJ/SC RWF	San José	24-mgd plant with FAT process plus O_3-BAC and chlorine disinfection
1d	TWA with direct delivery to Santa Clara, San José, San Jose Water	SJ/SC RWF	San José	24-mgd plant with FAT process plus O_3-BACand chlorine disinfection
2a	Combined Regional AWPF located in Palo Alto delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto Regional Water Quality Control Plant (RWQCP) and Sunnyvale Water Pollution Control Plant (WPCP)	Palo Alto	24.5-mgd plant with FAT process, including equalization basin
2b	Combined Regional AWPF located in Sunnyvale delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto RWQCP and Sunnyvale WPCP	Sunnyvale	24.5-mgd plant with FAT process, including equalization basin
4a	Separate Regional AWPFs in Palo Alto and Sunnyvale delivering water to Los Gatos Recharge Ponds for GWR.	Palo Alto RWQCP	Palo Alto	14-mgd plant with FAT process, including equalization basin
4b		Sunnyvale WPCP	Sunnyvale	10.5-mgd plant with FAT process, including equalization basin
Westside TWA	Combined Regional AWPF located in Palo Alto delivering TWA water to the West Pipeline at Stevens Creek.	Palo Alto RWQCP and Sunnyvale WPCP	Palo Alto	24.5-mgd plant with FAT process plus ozone-BAC and chlorine disinfection, including equalization basin

Notes:

Assume FAT system includes ultrafiltration (UF) system > reverse osmosis (RO) system > decarbonator system > ultraviolet/advanced oxidation process (UV/AOP) > purified water

A.1.2 Water Quality

Estimated feed water quality presented in Table A-2 is based on *Expedited Purified Water Program Direct Potable Reuse Facilities Plan.* The data were assembled from historical SJ/SC RWF data collected monthly (March 2011 to March 2016) and supplemented with quarterly and grab sample data. These data were assumed as a basis for designing each North County AWPF. Variations in actual water quality from other North County treatment facilities could result in different capital or operations and maintenance (O&M) costs but are not considered at this level of analysis.

Table A-2. Estimate Feed Water Quality

		Historical data				
Parameter	**Units**	**Min**	**Max**	**90th Percentile**	**Average**	**Design value**
1, 4-dioxane	µg/L	--	--	--	--	4.4
Alkalinity, total	mg/L as $CaCO_3$	--	--	--	--	152
Ammonia, total	mg/L as N	0.16	3.2	1.3	0.75	1.3
Calcium	mg/L	--	--	--	--	44
Chloride	mg/L	--	--	--	--	267
Chlorine, total residual	mg/L	--	--	--	--	0.5
Conductivity	µS/cm	--	--	--	--	1,600
Magnesium	mg/L	--	--	--	--	26
NDMA	ng/L	--	--	--	--	100
Nitrate + nitrite (calculated)	mg/L as N	12	23	20	17	20
Nitrogen, total (as N)	mg/L	13	24	21	18	21
pH	unit	6.9	8.1	7.6	7.4	7.6
Phosphate	mg/L as PO_4	--	--	--	--	6.7
Silica	mg/L as SiO_2	--	--	--	--	24
Sodium	mg/L	--	--	--	--	200
Sulfate	mg/L	--	--	--	--	86
Total dissolved solids (TDS)	mg/L	650	990	851	770	851
Temperature	°C	14	26	24	21	14
Total organic carbon (TOC)	mg/L	7	43	9	9	10
Total Kjeldahl Nitrogen (TKN) (as N)	mg/L	1.1	3.9	2.0	1.6	2.0
Turbidity	NTU	0.0	4.0	1.70	1.2	1.7

Notes: Source: Valley Water, "Expedited Purified Water Program Plan, Appendix C – Direct Potable Reuse Facilities Plan." February 2018.

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

$CaCO_3$ = calcium carbonate

mg/L = milligrams per liter

ng/L – nanogram per liter

NDMA = N-nitrosodimethylamine

NTU = Nephelometric turbidity unit

A.1.3 Influent Pump Station/Equalization Basin

Wastewater effluent from the sources identified in Table A-1 would be conveyed to each of the respective AWPFs being considered. For Palo Alto and Sunnyvale AWPFs, wastewater effluent would be conveyed into equalization basins upstream of treatment. The influent pumps described in Table A-3 would convey water through the influent strainers and UF filter modules. A disinfection residual (chloramines) is assumed to be provided at the influent pump station/ equalization basin, upstream of the UF system to minimize biofouling of the UF and RO membranes. Chemicals used and dosing amounts are noted in Table A-3.

Table A-3. Influent Pump Station Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Feed flow	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Wetwell/equalization basin volume	MG	0.5	0.5	0.5	3.0	3.0	2.5	2.0
Number of pumps	--	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby	4 duty 1 standby
Type	--	Vertical diffusion vane pump[a]	Vertical diffusion vane pump[a]	Vertical diffusion vane pump[a]	Vertical turbine pump	Vertical turbine pump	Vertical turbine pump	Vertical turbine pump
Capacity, each	gpm	7,600	7,600	7,600	5,400	5,400	3,200	2,400
Total dynamic head (TDH), each	ft	±133	±133	±133	±105	±105	±106	±106
Motor size	hp	500	500	500	200	200	125	100
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
Variable-frequency Drive (VFD)	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hypochlorite dose for chloramine residual	mg/L	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]	1.5[b,c]
Aqueous ammonia dose for chloramine residual	mg/L	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]	0.5[c]

Influent pump station design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 2a.

a. Match existing pumps and equipment/piping materials at SVAWPC.

b. Estimated dose for 2 mg/L chloramine residual.

c. Assumes 0.5 mg/L residual from disinfected tertiary effluent.

MG = million gallons

SVAWPC = Silicon Valley Advanced Water Purification Center

A.1.4 Ozone and Biologically Activated Carbon

Based on the *Expedited Purified Water Program Plan* RWA AWPF concept, O_3-BAC pretreatment is recommended for the RWA and TWA treatment train to gain log removal value (LRV) credit and improve downstream processes, including disinfection, total organic carbon (TOC) reduction, and membrane performance. Details for the O_3-BAC system are presented in Table A-4 and based on information provided by WEDECO, Inc.

Table A-4. Ozone and BAC Design Criteria for Portfolio 1b

Parameter	Units	SJ/SC RWF	
		1b (RWA)	1c and 1d (TWA)
Ozone System			
Ozone range:TOC (ratio)	N/A (ratio)	0.6-1.3:1	0.6-1.3:1
Ozone dose	mg/L	6	6
Number of contactors	--	5	5
Ozone contact time (including quenching)	min	10	10
Ozone generator capacity, each	pounds per day (lb/day)	875	875
Number of ozone generators	--	2	2
Number of vaporizers	--	2	2
Capacity, each	gal	4,000	4,000
Liquid oxygen (LOX) tank capacity, each	gal	15,000	15,000
Number of LOX tanks	--	2	2
BAC System			
Number of filters (duty + standby)	--	7+1	7+1
Filter depth (granular activated carbon [GAC], sand)	in.	72, 12	72, 12
Design empty bed contact time (EBCT)(assumes 1 unit down)	min	14	14
Design loading rate (assumes 1 unit down)	Gallons per minute per square foot (gpm/ft^2)	4.3	4.3

Ozone and BAC design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

A.1.5 Ultrafiltration System

The UF system for this application consists of strainers followed by UF membranes. Design criteria for both are based on information provided by Pall, Inc. (Tables A-5 and A-6).

Table A-5. Strainer Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	**Units**	**1a (GWR)**	**1b (RWA)**	**1c and1d (TWA)**	**2a (GWR)**	**2b (GWR)**	**4 (GWR), 1 of 2**	**4b (GWR), 2 of 2**
Design feed flow	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Number of strainers	--	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	5 duty, 1 standby	3 duty, 1 standby	3 duty, 1 standby
Design flow, each	mgd	6.1	6.1	6.1	6.3	6.3	6.0	4.5
Vessel material	--	316 SS	316 SS	316 SS	316 SS	316 SS	316 SS	316 SS
Min. screen pore size (nominal)	µm	300	300	300	300	300	300	300
Approximate strainer headloss, average	psi	5	5	5	5	5	5	5
Screen material	--	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)	316 SS (punched hole or woven mesh)
Manufacturer	--	Pall	Pall	Pall	Pall	Pall	Pall	Pall

Strainer design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
SS = stainless steel

Table A-6. Pressure UF System Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	**Units**	**1a (GWR)**	**1b (RWA)**	**1c and 1d (TWA)**	**2a (GWR)**	**2b (GWR)**	**4 (GWR), 1 of 2**	**4b (GWR), 2 of 2**
Manufacturer	--	Pall	Pall	Pall	Pall	Pall	Pall	Pall
Recovery	%	92%	92%	92%	92%	92%	92%	92%
Feed (all trains)	mgd	30.7	30.7	30.7	31.3	31.3	17.9	13.4
Reverse filtration flow, all trains (backwash)	mgd	2.5	2.5	2.5	2.5	2.5	1.4	1.1
Effluent (all trains)	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Operation type (pressure/vacuum)	--	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure	Pressure
Number of trains	--	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	9 duty, 1 standby	5 duty, 1 standby	4 duty, 1 standby
Design flux	gfd	20-30	50-60	50-60	20-30	20-30	20-30	20-30
Number of modules	per train	270	270	270	270	270	270	270
Number of modules	total	2,700	2,700	2,700	2,700	2,700	1,620	1,350
Operating transmembrane pressure, max.	psi	40	40	40	40	40	40	40
Cleaning frequency								
Maintenance clean	day	1	1	1	1	1	1	1
CIP	month	1	1	1	1	1	1	1

Pressure UF system design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
CIP = clean in place
gfd = gallons per square foot per day

A.1.6 Reverse Osmosis System

The RO system would consist of UF/RO interprocess tanks, RO transfer pumps, cartridge filters, RO feed pumps, and the RO treatment vessels. System details are based on information provided by Pall, Inc., and are described in Tables A-7 through A-11.

Table A-7. UF/RO Interprocess Tank Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO feed tank flow	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Number of tanks	--	2	2	2	2	2	2	2
Design detention time	min	15	15	15	15	15	15	15
Operating volume, each	gal	169,200	169,200	169,200	169,200	169,200	95,200	82,900
Height	ft	18	18	18	18	18	18	18
Diameter	ft	40	40	40	40	40	30	28
Tank type	--	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade	304 SS, cylindrical, above grade

UF/RO interprocess tank design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-8. RO Transfer Pump Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO feed flow, design	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
Type	--	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction	Horizontal end suction
Number of pumps	--	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	4 duty, 1 standby	5 duty, 1 standby	4 duty, 1 standby
Capacity, each	gpm	5,000	5,000	5,000	5,000	5,000	2,600	2,600
TDH, each	ft	100	100	100	100	100	100	100
Motor size	hp	200	200	200	200	200	100	100
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
VFD	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes

RO transfer pump design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-9. RO Cartridge Filter Design Criteria								
Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Number of units	quantity	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Configuration	--	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Number of elements	per housing	220	220	220	220	220	220	220
Number of elements	total	2,200	2,200	2,200	2,200	2,200	1,320	1,110
Type	--	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal	Melt blown polypropylene or equal
Pore size	μm	5	5	5	5	5	5	5
Diameter	in.	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Length	in.	40	40	40	40	40	40	40
Design headloss, max.	psi	15	15	15	15	15	15	15

RO cartridge filter design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-10. RO Feed Pumps Design Criteria								
Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Type	--	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine	Vertical turbine
Number of pumps	--	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Capacity, each	gpm	1,960	1,960	1,960	2,000	2,000	1,910	1,725
Maximum design operation pressure	psi	300	300	300	300	300	300	300
Motor size	hp	450	450	450	500	500	450	400
Pump efficiency	%	±80%	±80%	±80%	±80%	±80%	±80%	±80%
VFD	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes

RO feed pump design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-11. RO System Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
RO flow rates (total)	--							
Feed	mgd	28.2	28.2	28.2	28.8	28.8	16.5	12.4
RO concentrate	mgd	4.2	4.2	4.2	4.3	4.3	2.5	1.85
Permeate	mgd	24.0	24.0	24.0	24.5	24.5	14.0	10.5
Number of trains	--	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	10 duty, 0 standby	6 duty, 0 standby	5 duty, 0 standby
Permeate per train	mgd	2.4	2.4	2.4	2.45	2.45	2.33	2.1
Train configuration								
Number of stages	--	3	3	3	3	3	3	3
Array configuration (per train)	pressure vessels by stage	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13	45:25:13
Pressure vessels	per train	83	83	83	83	83	83	83
RO elements								
Type	--	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound	Spiral wound
Material	--	TFC	TFC	TFC	TFC	TFC	TFC	TFC
Diameter	Inch (in)	8	8	8	8	8	8	8
Length	in	40	40	40	40	40	40	40
Area	sf	400	400	400	400	400	400	400
Number of elements	per pressure vessel	7	7	7	7	7	7	7
Number of elements	total	5,810	5,810	5,810	5,810	5,810	3,486	2,905
Nominal sodium chlorine reduction	%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%	>99.2%
Permeate TOC	mg/L	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25
System recovery	%	85%	85%	85%	85%	85%	85%	85%
Anti-scalant to RO feed	mg/L	3	3	3	3	3	3	3
Sulfuric acid to RO feed	mg/L	6.1	6.1	6.1	6.1	6.1	6.1	6.1

RO system design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
TFC = thermo formable composite

A.1.7 Decarbonation/Air Stripping System

The RO permeate that feeds into the AOP has a high corrosivity that could corrode the product water conveyance pipelines depending on pipe material. To mitigate potential corrosion, decarbonation/air stripping towers are proposed to stabilize the product water through the removal of dissolved CO_2, which increases the pH of the water. This also reduces the level of chemical consumption associated with post treatment stabilization. The decarbonators/air strippers also help reduce water temperature to address aesthetics concerns and provide an additional mechanism of chemical control (volatilization) to complement other barriers. As currently configured, decarbonation is located upstream of the AOP due to the assumption that the UV system will use hydrogen peroxide, consistent with previous studies and the existing SVAWPC system. In many designs, decarbonation is either located downstream of UV-AOP or not included, depending on unconditioned treated water quality and final water quality goals. Relocation of decarbonation downstream of the UV-AOP to allow for flexibility in UV-AOP oxidant selection and optimize water stabilization is recommended for consideration. Table A-12 describes the decarbonator design criteria.

Table A-12. Decarbonator/Air Stripping Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Manufacture, model	--	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical	Daniel Mechanical
Number of units	--	4	4	4	4	4	3	2
Tank height	ft	14	14	14	14	14	14	14
Diameter	ft	12	12	12	12	12	11	12
Air flow rate, per unit	cfm	15,000	15,000	15,000	15,000	15,000	15,000	15,000
Blower size, per unit	hp	20	20	20	20	20	20	20
Treatment flow rate (each)	gpm	4,167	4,167	4,167	4,254	4,254	2,431	1,823
Loading rate, per unit	gpm/sf	37	37	37	37	37	26	20

Decarbonator/air stripper design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
cfm = cubic feet per minute
hp = horsepower

A.1.8 Advanced Oxidation Process System

The third treatment operation for these facilities is an AOP using UV light and hydrogen peroxide to provide the primary barrier against pathogenic organisms. Details for the proposed systems are described in Table A-13.

Table A-13. Advanced Oxidation Process Design Criteria

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Sodium bisulfite dose	mg/L	3	3	3	3	3	3	3
Hydrogen peroxide dose range	mg/L	3-5	3-5	3-5	3-5	3-5	3-5	3-5
UV system								
Manufacturer, model	--	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200	Trojan UV Flex 200
Number of units	--	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	2 duty, 1 standby	1 Duty, 1 Standby	1 duty, 1 standby
Configuration	--	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In pipe, horizontal	In Pipe, Horizontal	In pipe, horizontal
Width	ft	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Length	ft	16.75	16.75	16.75	16.75	16.75	18.8	14.6
Lamp type	--	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output	Low pressure, high output
Number of UV lamps	per unit	288	288	288	288	288	336	240
Number of duty UV lamps	total	576	576	576	576	576	336	240
UV lamp power	kW per lamp	1.0	1.0	1.0	1.0	1.0	1.0	1.0
UV reactor power	kW per unit	615	615	615	615	615	358	256
Total duty UV system power	kW	615	615	615	615	615	358	256
UVT (minimum, estimated)	%	96%	96%	96%	96%	96%	96%	96%
UV dose	mJ/cm^2	900	900	900	900	900	900	900

Advance oxidation process design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.
kW = kilowatt
UVT = ultraviolet transmittance

A.1.9 Post Treatment Stabilization Process

After decarbonation, chemical addition completes the process of stabilizing purified water with estimated chemical dosing as presented in Table A-14.

Table A-14. Post-Treatment Stabilization and Chemical Requirements[a]

Parameter	Units	SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
		1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
LSI	--	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
Sodium hydroxide	mg/L	11	11	11	11	11	11	11
Lime	mg/L	12	12	12	12	12	12	12
Sodium hypochlorite[b]	mg/L	19	19	NA	19	19	19	19

Post treatment stabilization and chemical requirements for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

a. Note: Chemical doses were estimated based on the RO modeling software and would need to be validated in the field.

b. Sodium hypochlorite dose represents combined dose needed to quench residual hydrogen peroxide, achieve breakpoint chlorination, and provide free chlorine residual.

LSI = Langelier Saturation inex

A.1.10 Chlorine Disinfection Process

Based on the State Water Resources Control Board Division of Drinking Water's (DDW) current position on direct potable reuse (DPR), FAT is anticipated to be the minimum treatment baseline. Additional treatment elements will likely be needed to comply with stricter requirements for pathogen and chemical control. For TWA facilities, it was assumed that chlorine disinfection would form part of the minimum treatment requirements. Chlorine disinfection would provide another treatment barrier for viruses, and the residual free chlorine in the effluent flow from this process would safeguard against pathogen regrowth in downstream infrastructure. To receive 6/0/1 LRVs for this treatment step as discussed in D7, a minimum contact time (CT) of 37 min-mg/L is needed per *LT1ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual*. The design criteria for chlorine disinfection is provided in Table A-15.

Table A-15. Chlorine Disinfection Design Criteria for Portfolio 1c and 1d[a]

Parameter	Units	San José/Santa Clara Regional Wastewater Facility
		1c and 1d (TWA)
Flow	mgd	24.0
CT	min-mg/L	37
Sodium Hypochlorite Dose[b]	mg/L	20
Basin		
Free Chlorine Residual	mg/L	3
Reactor Type	--	Plug-flow
Reactor Length to Width Ratio	--	20:1
Reactor Baffling Factor	%	70
Side Water Depth	ft	8
Freeboard	ft	2
Number of Passes	--	3
Length per Pass	ft	200
Width per Pass	ft	10
Reactor Volume	gal	360,000

a. Chlorine disinfection design criteria for the Westside TWA Scenario would match criteria for Portfolio 1c and 1d.

b. Sodium hypochlorite dose represents an assumed combined dose needed to quench residual hydrogen peroxide, achieve breakpoint chlorination, and provide free chlorine residual. The assumed dose was estimated using data obtained from RO modeling software and will need to be updated and validated as these designs are further refined.

A.1.11 Purified Water Storage Clearwell

Once the purified water has been stabilized and disinfected, it will be conveyed to an onsite baffled clearwell. For the GWR and RWA portfolios, the clearwells were designed with a 4-hour retention time and are primarily meant to help equalize flow feeding the purified water pump stations. For the TWA portfolios, the clearwells are designed with an 8-hour retention time and will provide the ability to respond to upstream performance and water quality issues, serve as a hydraulic buffer to manage demands in the distribution system, and provide a location to divert off-spec water upstream of distribution. Design criteria for the clearwells are based on information provided by DN Tanks and is provided in Table A-16.

Table A-16. Purified Water Storage Clearwell Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Number of Tanks	--	1	1	2	1	1	1	1
Inside Diameter	ft	134	134	134	110	134	100	90
Side Water Depth	ft	39	39	39	56	39	40	37
Volume per Clearwell	gal	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	2,300,000	1,750,000
Freeboard	ft	5	5	5	5	5	5	5

Purified water storage clearwell design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 2a but would require two (2) tanks to accommodate 8-hour retention time.

A.1.12 UF Backwash Disposal

The types and flow rates of waste streams is summarized in Table A-17 for each AWPF. Design criteria for the waste equalization wetwell are presented in Table A-18.

Table A-17. Waste Side-Stream Flows

			Flow (mgd)						
			SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Waste Stream	Frequency	Percent of Feed Flows	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Strainer cleaning flows	Intermittent	<1% of facility influent flow	0.3	0.3	0.3	0.3	0.3	0.2	0.2
UF backwash waste flows	Intermittent	~8% of facility influent flow	2.5	2.5	2.5	2.6	2.6	1.3	1.3
RO concentrate flows	Continuous	~15% of RO feed flow	4.5	4.5	4.5	4.6	4.6	2.7	2.0
CIP solution flows	Intermittent	NA	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Waste side-stream flows for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

Table A-18. Waste Equalization Design Criteria

		SJ/SC RWF			Palo Alto RWQCP and Sunnyvale WPCP		Palo Alto RWQCP and Sunnyvale WPCP	
Parameter	Units	1a (GWR)	1b (RWA)	1c and 1d (TWA)	2a (GWR)	2b (GWR)	4 (GWR), 1 of 2	4b (GWR), 2 of 2
Wetwell volume	gal	219,000	219,000	219,000	201,000	201,000	135,800	105,300
Minutes of UF waste storage	min	90	90	90	90	90	90	90
Pump station								
Pump type	--	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump	Submersible Sewage Pump
Number of pumps	--	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	3 Duty, 1 Standby	2 Duty, 1 Standby	3 Duty, 1 Standby
Design flow, each	gpm	1,800	1,800	1,800	694	694	694	347
TDH	ft	35	35	35	34	32	32	21
Motor size	hp	40	40	40	10	10	10	3
VFD	--	No	No	No	TBD	TBD	TBD	TBD
Pipeline								
Pipeline diameter	in.	24	24	24	14	14	10	10
Pipeline length	LF	3,000	2,875	2,875	1,200	500	1,200	500
Pipeline material (match existing)	--	HDPE Pressure Pipe	Mortar Lined and Coated Steel Pipe	Mortar Lined and Coated Steel Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe	HDPE Pressure Pipe

Waste equalization design criteria for the Westside TWA Scenario would match criteria provided for Portfolio 1c and 1d.

HDPE = high-density polyethylene

A.2 Morgan Hill Satellite and AWPF Design Criteria

A.2.1 Influent Pump Station

The influent pump station was designed to handle a peak flow of 4.5 mgd and an average flow of 2.5 mgd. AFT Fathom (fluid dynamic simulation software) was used to determine the head and pump size. Table A-19 presents design criteria for the influent pump station.

Table A-19. Influent Pump Station Design Criteria

Parameter	Units	Value
Feed flow	mgd	4.5
Number of pumps	--	2 duty, 1 standby
Type	--	Submersible non-clog
Capacity, each	gpm	1,600
TDH, each	ft	10.2
Motor size	hp	7.5
Pump efficiency	%	70%
VFD	--	Yes

A.2.2 Headworks

The headworks layout consists of coarse screens, grit removal, fine screens, and associated facilities. The coarse and fine screens are important for protecting the downstream membranes and the grit chamber and for reducing grit buildup in the downstream biological reactors. The coarse screens are spiral screen with two duty and one bypass unit. A spiral screen was chosen due to its relatively compact footprint. The grit removal system is a mechanical vortex system chosen for its low energy cost and efficient removal at variable speeds. The fine screens are an internally fed rotary drum with two duty and one standby unit. The headworks were designed to handle a peak flow of 4.5 mgd and sized using industry standards and previous project designs. Table A-20 presents design criteria for the headworks.

Table A-20. Headworks Design Criteria

Parameter	Units	Value
Coarse screen		
Type	--	Submersible non-clog; spiral screen
Number	--	2 duty with bypass
Opening size	mm	6
Capacity (each)	mgd	2.25
Conveyor type	--	Shaftless screw
Compactor type	--	Screw compactor
Grit removal		
Type	--	Mechanical Vortex
Number	--	2 duty with bypass
Capacity (each)	mgd	2.25
Conveyor type	--	Screw Press
Fine screens		
Type	--	Internally fed rotary drum
Number	--	2 duty, 1 standby
Opening size	mm	2
Capacity (each)	mgd	2.25
Motor size	hp	0.5

A.2.3 Equalization Basin and Intermediate Pump Station

The equalization basin, which is envisioned as a partially buried concrete structure, would capture and balance diurnal peak flows upstream of treatment. As Morgan Hill flow data are not available, a typical diurnal curve[1] for small systems was used to estimate the storage required for an average flow of 2.5 mgd. The estimated volume for the facility was 0.22 MG, including a 15 percent safety factor. The intermediate pump station pumps flow to the membrane bioreactor (MBR) system and was sized using AFT Fathom. Tables A-21 and A-22 present design criteria for the equalization basin and intermediate pump station.

Table A-21. Equalization Basin Design Criteria

Parameter	Units	Value
Width x length	ft x ft	35 x 45
Operating water range	ft	22
Freeboard above max water level	ft	2
Tank height	ft	24
Equalization volume	MG	0.22

Table A-22. Intermediate Pump Station Design Criteria

Parameter	Units	Value
Type	--	Submersible non-clog
Number	--	2 duty, 1 standby
Capacity (each)	gpm	1,600
TDH	ft	10.2
Motor size	hp	7.5

A.2.4 Membrane Bioreactor System

The MBR process uses a membrane filter for liquid/solids separation to produce tertiary effluent. This process does not require secondary clarifiers or tertiary filters because the membranes achieve clarification/filtration in one step. The biological nutrient removal (BNR) basins will consist of a de-oxygenation zone so that residual dissolved oxygen (DO) from the membrane tanks will be consumed biologically, followed by a baffled anoxic zone then an aeration zone. The MBR system will be designed with two parallel BNR basins and three parallel membrane tanks. The MBR system criteria was developed using a process modeling software called BioWin 6.0. The main model input values include influent flow, biological oxygen demand (BOD), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorus, and temperature. The model indicated a needed aeration basin volume of 0.52 MG and return activated sludge pumps operated at 400 percent of influent flow. Table A-23 presents design criteria for the membrane bioreactor system.

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[1] Crites & Tchobanoglous, Small and Decentralized Wastewater Management Systems,

Table A-23. Bioreactor System Design Criteria		
Parameter	**Units**	**Value**
Mixed liquor suspended solids (MLSS)	mg/L	7,100
Mean cell residence time (MCRT) (solids retention time [SRT]) at average flow	days	10
Number of trains	--	2
Number of pre-anoxic basins	--	2
Volume, total	MG	0.24
Width x length (each basin)	ft x ft	20 x 45
Water depth (per train)	ft	18
Number of aeration basins (per train)	--	2
Volume, total	MG	0.48
Width x length (each basin)	ft x ft	20 x 90
Water depth	ft	18
Number of de-oxygenation basins (per train)	--	2
Volume, total	gal	50,000
Width x length (each basin)	ft x ft	20 x 10
Water depth	ft	18
Membrane reactor		
Total volume	MG	0.09
Cassettes per train	ft	10
Chloramination		
Hypochlorite dose for chloramine residual	mg/L	1.5
Aqueous ammonia Dose for chloramine residual	mg/L	0.5

A.2.5 Blowers and Mixers

Blowers and mixers are used as part of the MBR system to move continuously mixed fluid through the tanks and prevent settling. Sizing needed for air requirements were made from a Brown and Caldwell (BC) standardized spreadsheet. Table A-24 presents design criteria for the blowers and mixers.

Table A-24. Blowers and Mixers Design Criteria		
Parameter	**Units**	**Value**
Aeration blowers		
Standard cubic feet per minute (scfm) (each)	--	7,000
Number of blowers	--	2 duty, 1 standby
TDH	psi	10
Motor size	hp	220
Mixers	--	2
Number	--	2 duty
Motor size	hp	1

A.2.6 RAS/WAS Pump Systems

The return activated sludge (RAS) pumps return sludge from the membrane area to the head of the process train at the deoxygenation basin. Waste activated sludge (WAS) pumps send waste sludge from the end of the process to a waste wetwell that will connect to a trunk sewer. The pumps were sized using the following equation with an assumed head of 5 feet, efficiency of 70 percent, and individual design flows:

$$hp = (flow \times head)/(3960 \times efficiency).$$

Table A-25 presents design criteria for the RAS and WAS pumps.

Table A-25. RAS and WAS Pumps Design Criteria

Parameter	Units	Value
Mixed liquor recycle pumps (RAS)		
Number	--	2 duty, 1 standby
Capacity (each)	gpm	6,944
TDH	ft	5
Motor size	hp	15
Waste activated sludge pumps (WAS)		
Number	--	2 duty, 1 standby
Capacity (each)	gpm	65
TDH	ft	5
Motor size	hp	1

A.2.7 RO System

The main components of the RO system consist of cartridge filters, feed pumps within the RO wetwell, RO unit (including skids), CIP system with tanks and RO pumps, and permeate flush tanks. The RO system was designed around a flux of 12 gfd and RO recovery of 85 percent. Design criteria for the RO system are presented in Tables A-26 through A-31.

Table A-26. RO Interprocess Tank Design Criteria

Parameter	Units	Value
RO feed tank flow	mgd	2.5
Flux	gfd	12
RO recovery rate	%	85%
No. of tanks	--	1
Design detention time	min	15
Operating volume, each	gal	26,042
Height	ft	10
Diameter	ft	30
Tank type	--	Steel, cylindrical, above grade

Table A-27. RO Transfer Pump Design Criteria		
Parameter	**Units**	**Value**
RO feed flow	mgd	2.5
Type	--	Horizontal end suction
No. of Pumps	--	1 duty, 1 standby
Capacity, each	gpm	1,736
TDH, each	ft	45
Motor size	hp	2
Pump efficiency	%	±80%
VFD	--	Yes

Table A-28. RO Cartridge Filter Design Criteria		
Parameter	**Units**	**Value**
No. of units	--	2 duty
Configuration	--	Parallel
No. of elements (per housing)	per housing	62
No. of elements (total)	total	124
Type	--	Melt blown polypropylene or equal
Pore size	µm	5
Vessel diameter	in.	27
Length	in.	40
Design headloss, max	psi	15

Table A-29. RO Feed Pump Design Criteria		
Parameter	**Units**	**Value**
Type	--	Vertical turbine
No. of pumps	--	2 duty
Capacity, each	gpm	858
TDH, each	psi	260
Motor size	hp	210
Pump efficiency	%	80%
VFD	--	Yes

Table A-30. RO System Design Criteria

Parameter	Units	Value
RO flow rates (total)		
Feed	mgd	2.5
RO concentrate	mgd	0.4
Permeate	mgd	2.1
RO system recovery rate	%	85
No. of trains	---	2 duty
Permeate per train	mgd	1.05
Train configuration	--	--
No. of stages	---	3
Array configuration (per train)	pres. vessels by stage	20:10:05
Pressure vessels	per train	35
Stage 3 boost pumps		
Number of pumps	---	1
Motor size, each	hp	40
TDH boost	pounds per square inch (psi)	30
RO element data		
Type	---	Spiral wound
Diameter	in.	8
Length	in.	40
No. of elements	per pressure vessel	7
No. of elements	total	245
Nominal sodium chloride rejection	---	>99.2%
Permeate TOC	mg/L	≤0.25
Anti-scalant to RO feed	mg/L	3
Sulfuric Acid to RO feed	mg/L	6.1

Table A-31. RO CIP System

Parameter	Units	Value
CIP flow rate	gpm	800
CIP pump head	psig	60
CIP horsepower	hp	20
CIP tank diameter	ft	7
CIP frequency (per year)	--	6

A.2.8 Decarbonation System

Table A-32 describes the decarbonator design criteria for the Morgan Hill AWPF.

Table A-32. Decarbonation Criteria

Parameter	Units	Value
Decarbonator towers		
Manufacturer	--	Daniel Mechanical
No. of units	--	1
Tank height	ft	14
Diameter	ft	8
Air flow rate, per unit	cfm	15,000
Blower size, per unit	hp	20
Treatment flow rate (each)	gpm	1,458
Loading rate, per unit	gpm/sf	29

A.2.9 Advanced Oxidation Process (UV/AOP) System

UV/AOP uses high-intensity ultraviolet light combined with an oxidant such as chlorine or hydrogen peroxide for destruction of many contaminants of emergency concern(CEC). Hydrogen peroxide is the assumed oxidant in this analysis. UV/AOP system was designed to meet the design requirements effective for disinfection, providing up to 6-log inactivation of viruses, *Cryptosporidium*, and *Giardia*. Table A-33 presents the design criteria for the UV/AOP system.

Table A-33. UV/AOP Criteria		
Parameter	**Units**	**Value**
Sodium bisulfite dose	mg/L	3
Hydrogen peroxide dose	mg/L	2.8
UV system		
Manufacturer, model	--	TrojanUV, Flex 200
Number of units	--	1 duty, 1 standby
Configuration	--	In pipe, horizontal
Width	ft	8.33
Length	ft	10.25
Lamp type	--	Low pressure, high output
Number of UV lamps	per unit	72
Number of duty UV lamps	total	72
UV lamp power	kW per lamp	0.72
UV reactor power	kW per unit	52
Total duty UV system power	kW	52
UVT (minimum, estimated)	%	96%
UV dose	mJ/cm^2	900

mJ/cm_2 = millijoule per square centimeter

A.2.10 Post-Treatment Stabilization Process

Product water stabilization is necessary to prevent corrosion of the distribution system after RO treatment. Under the assumed treatment strategy, the use of decarbonation is the initial step to treat the treated effluent, and the addition of both sodium hydroxide and lime would help complete the stabilization process. The addition of sodium hydroxide increases pH and calcium chloride increases mineral content. Table A-34 presents design criteria for the post-treatment stabilization process.

Table A-34. Post-Treatment Stabilization and Chemical Requirements		
Parameter	**Units**	**Value**
LSI	--	0-0.5
Sodium hydroxide	mg/L	11
Lime	mg/L	12

Appendix A-4: Preliminary Project Designs

Process Flow Diagrams

Site Layouts

Notes regarding site layouts and process flow diagrams for three potential facilities:

- Palo Alto NPR+ AWPF: Prepared by MNS Engineers, Inc. as part of the Advanced Water Purification System Preliminary/Conceptual Design Report
- Sunnyvale NPR+ AWPF: Mirrors the concept developed for the Palo Alto NPR+ AWPF and not included as part of this attachment
- New or expanded SJ/SC NPR+ facility: Mirrors that of the existing SVAWPC. Thus, the SVAWPC site layout and process flow diagram are included in this attachment to provide a basis.

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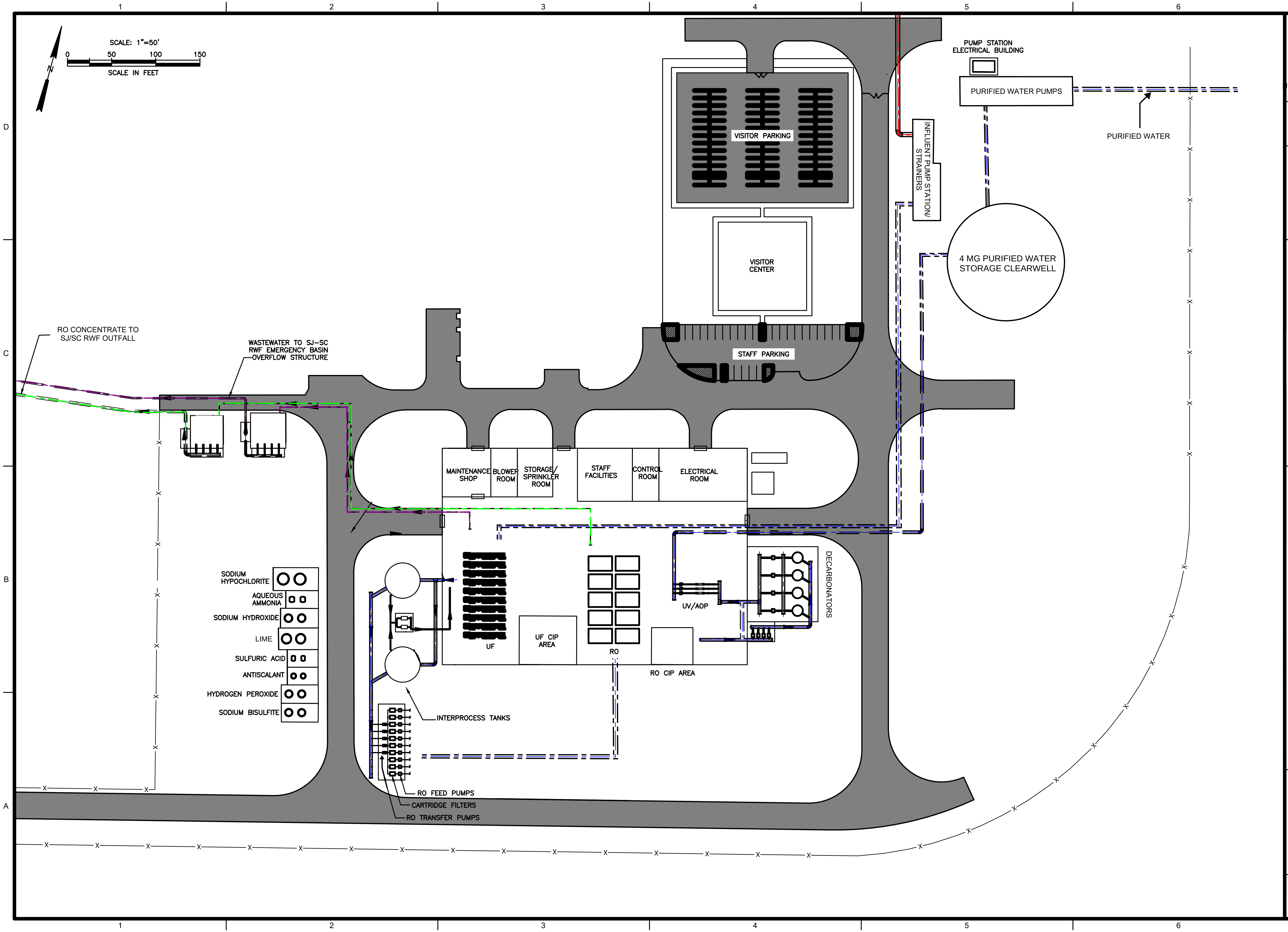


Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

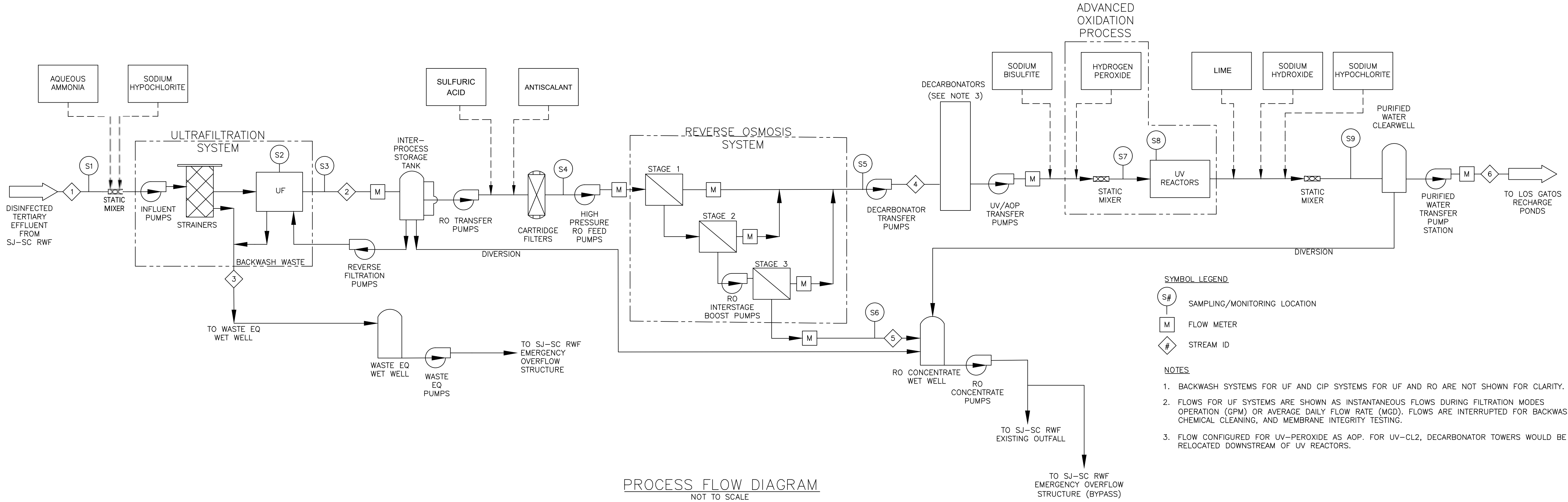
Valley Water

GENERAL

SAN JOSE/ SANTA CLARA
24 MGD AWPF

PORTFOLIO 1A

DRAWING NUMBER
1 OF 23



PROCESS FLOW DIAGRAM
NOT TO SCALE

NOTES

1. BACKWASH SYSTEMS FOR UF AND CIP SYSTEMS FOR UF AND RO ARE NOT SHOWN FOR CLARITY.
2. FLOWS FOR UF SYSTEMS ARE SHOWN AS INSTANTANEOUS FLOWS DURING FILTRATION MODES OPERATION (GPM) OR AVERAGE DAILY FLOW RATE (MGD). FLOWS ARE INTERRUPTED FOR BACKWASH, CHEMICAL CLEANING, AND MEMBRANE INTEGRITY TESTING.
3. FLOW CONFIGURED FOR UV-PEROXIDE AS AOP. FOR UV-CL2, DECARBONATOR TOWERS WOULD BE RELOCATED DOWNSTREAM OF UV REACTORS.

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	30.7	21,300
2	28.2	19,600
3	2.46	1,700
4	24.0	16,700
5	4.24	2,900
6	24.0	16,700

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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

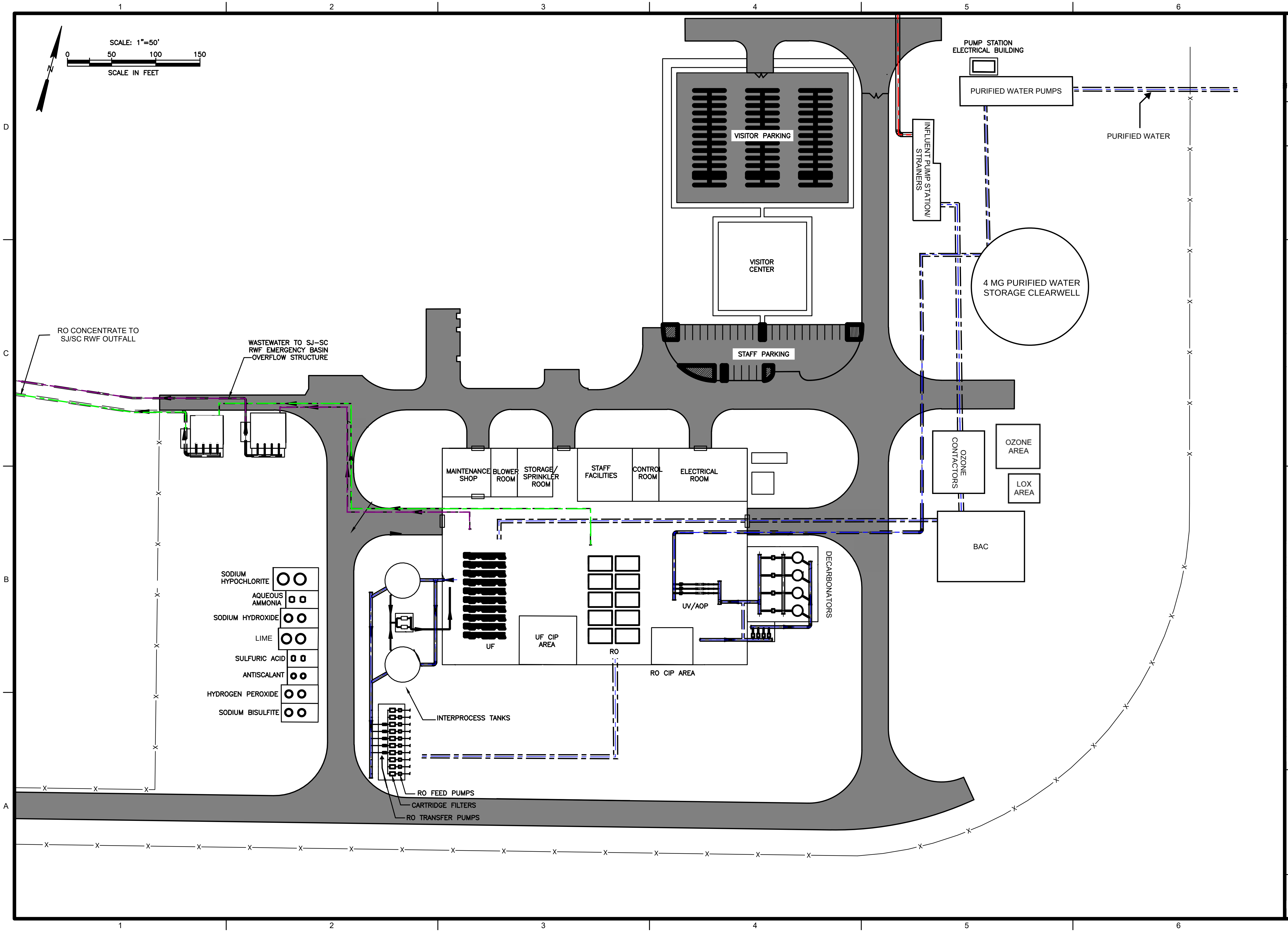
GENERAL

SAN JOSE/SANTA CLARA 24
MGD AWPF

PORTFOLIO 1A

PROCESS FLOW DIAGRAM

DRAWING NUMBER
2 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

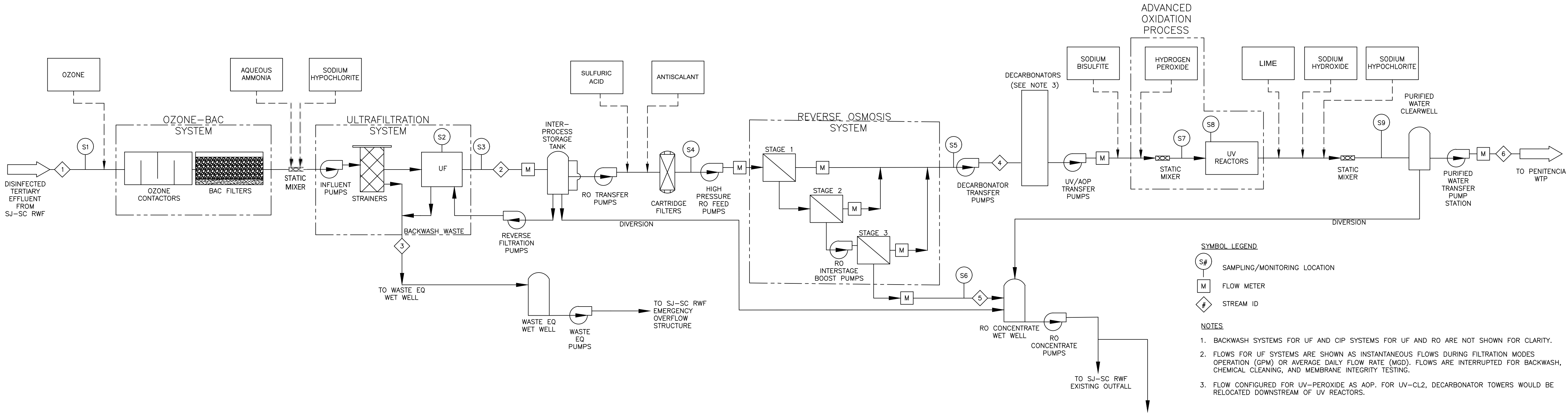
GENERAL

SAN JOSE/ SANTA CLARA 24 MGD AWPF FOR RWA

PORTFOLIO 1B

DRAWING NUMBER

3 OF 23



NOTES

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PROCESS FLOW DIAGRAM
NOT TO SCALE

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5	4.24	2,900
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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

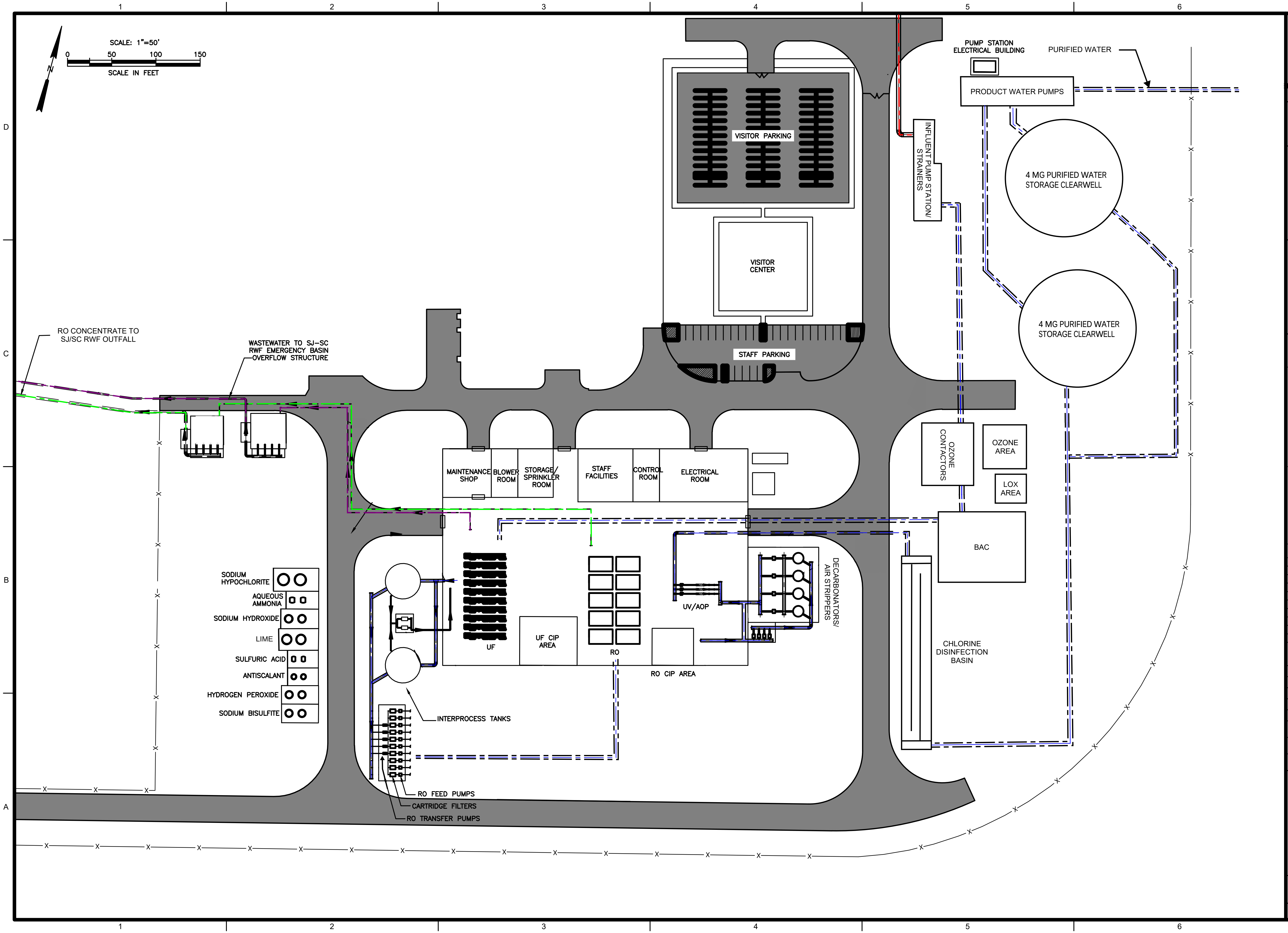
GENERAL

SAN JOSE/SANTA CLARA 24 MGD AWPF

PORTFOLIO 1B

PROCESS FLOW DIAGRAM

DRAWING NUMBER
4 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

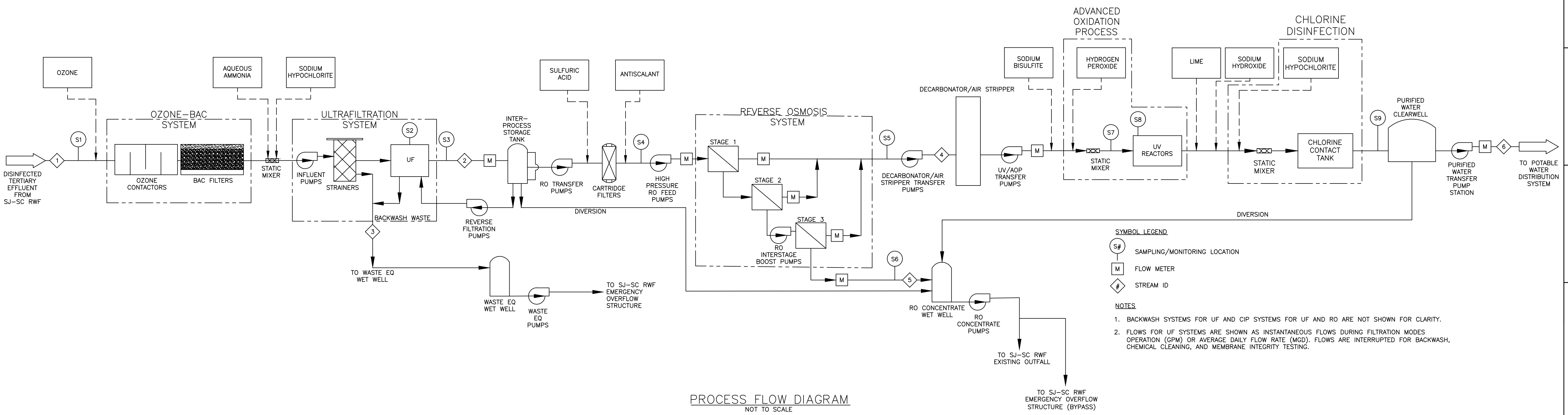
GENERAL

SAN JOSE/ SANTA CLARA
24 MGD AWPF FOR TWA

PORTFOLIO 1C and 1D

DRAWING NUMBER

5 OF 23



SYMBOL LEGEND

S# SAMPLING/MONITORING LOCATION

M FLOW METER

STREAM ID

NOTES

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PROCESS FLOW DIAGRAM

NOT TO SCALE

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3	2.5	1,700
4	24.0	16,700
5	4.2	2,900
6	24.0	16,700

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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

GENERAL

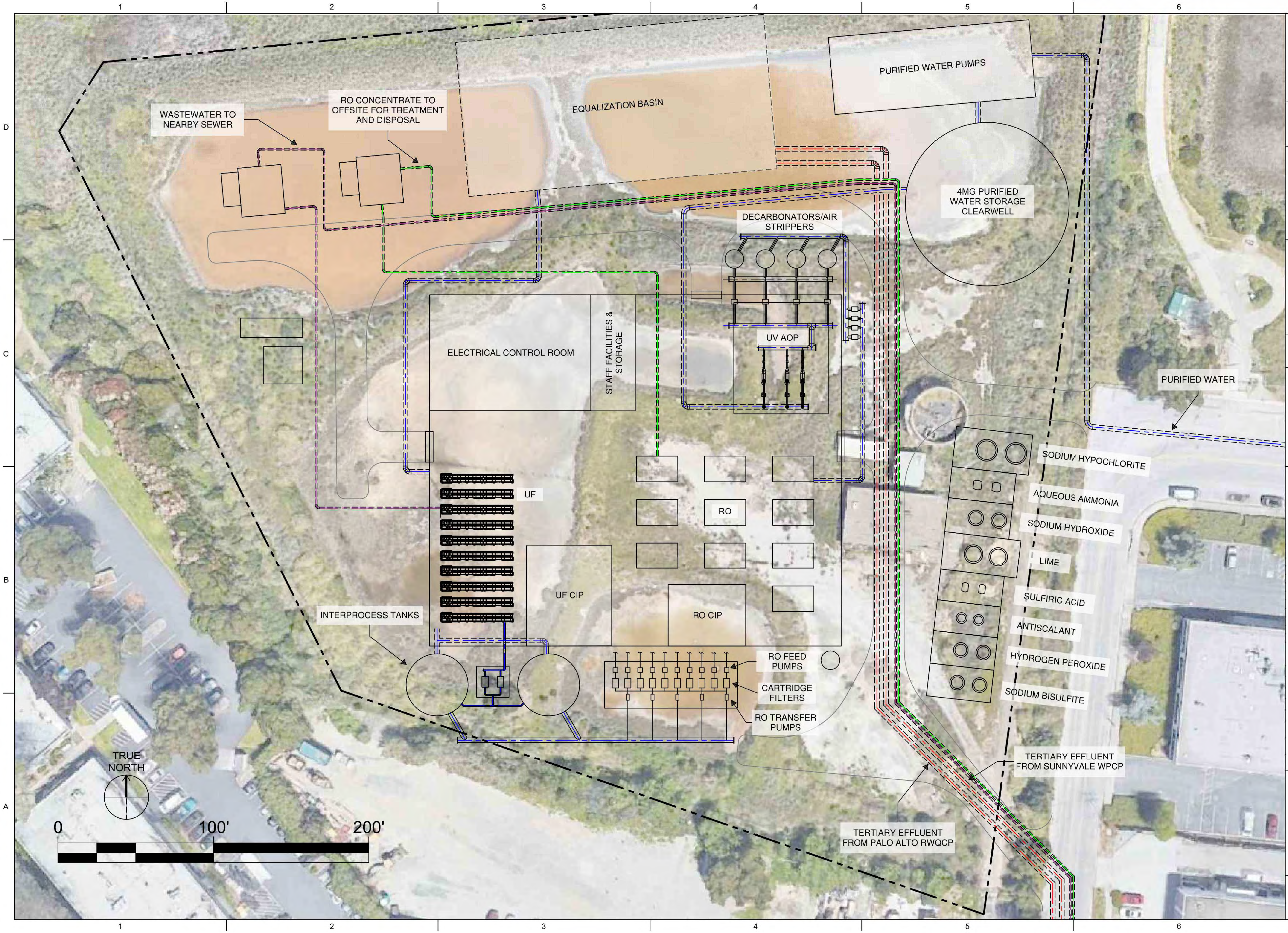
SAN JOSE/ SANTA CLARA
24 MGD AWPF FOR TWA

PORTFOLIO 1C AND 1D

PROCESS FLOW DIAGRAM

DRAWING NUMBER

6 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

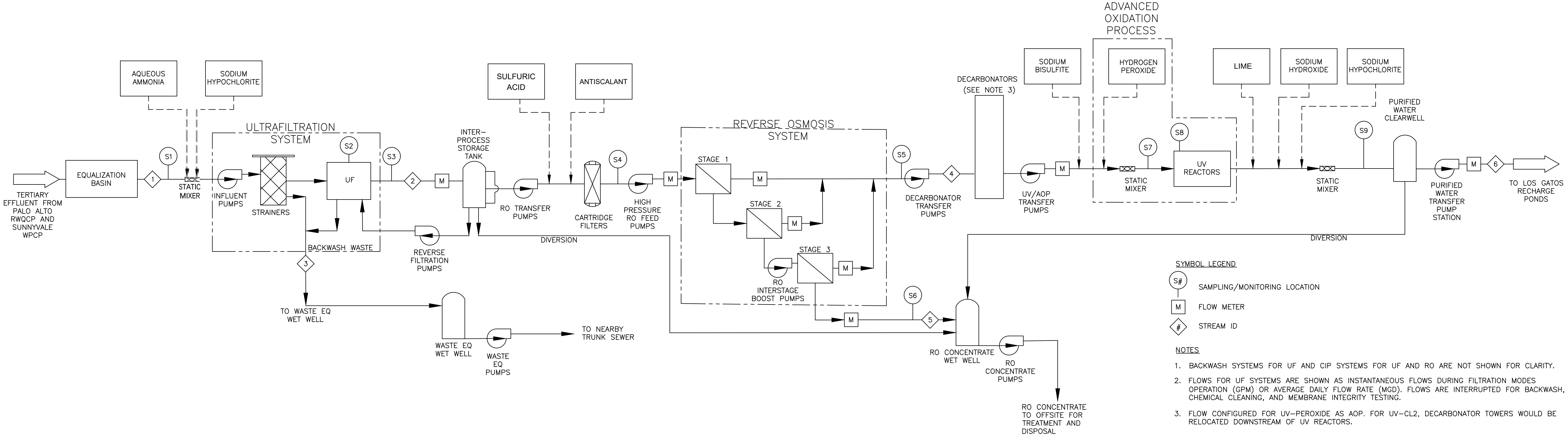
GENERAL

PALO ALTO 24.5 MGD COMBINED REGIONAL AWPF

PORTFOLIO 2A

DRAWING NUMBER

7 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇1	31.3	21,700
◇2	28.8	20,000
◇3	2.50	1,700
◇4	24.5	17,000
◇5	4.32	3,000
◇6	24.5	17,000

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SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

Valley Water

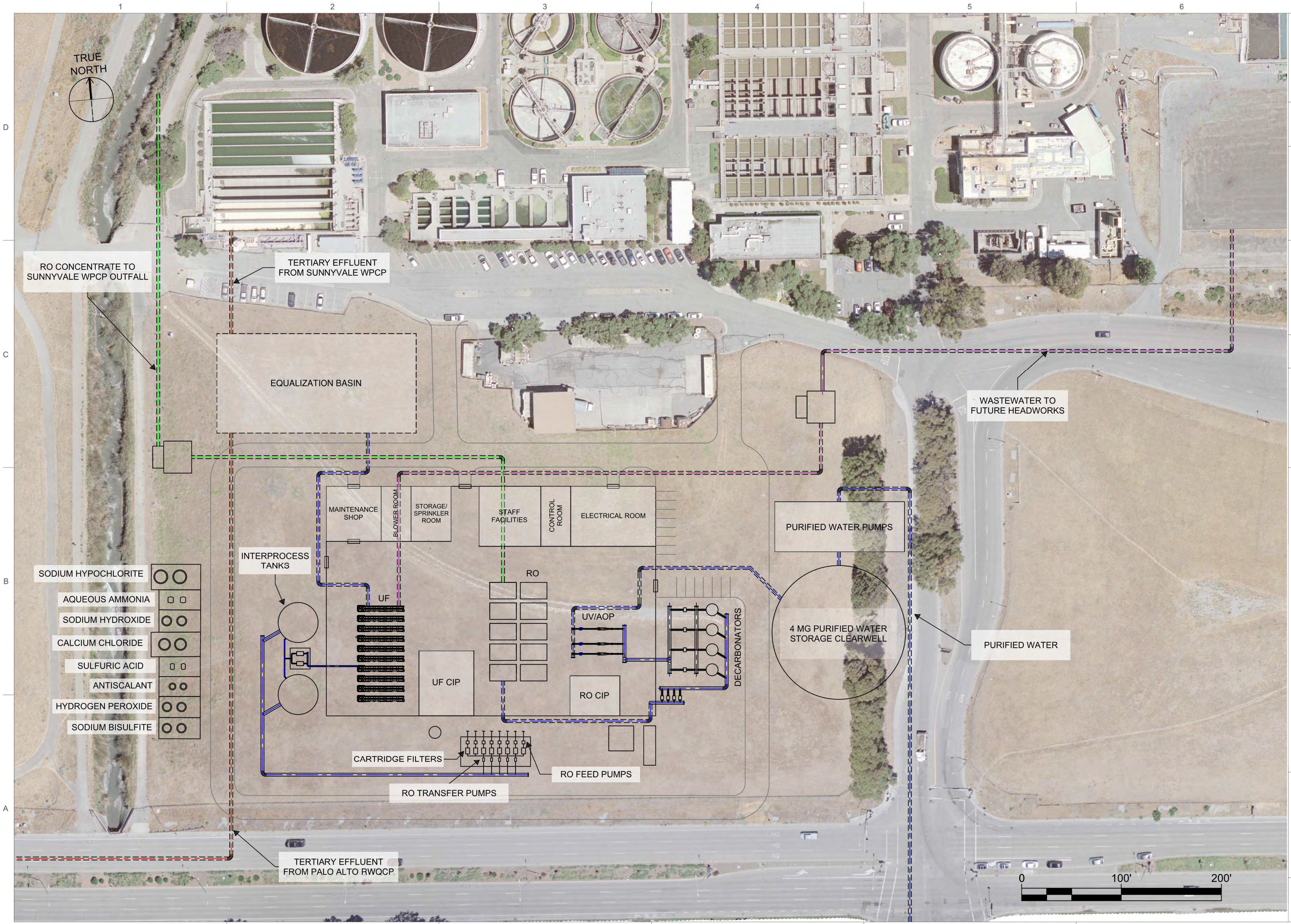
GENERAL

PALO ALTO 24.5 MGD
COMBINED REGIONAL AWPF

PORTFOLIO 2A

PROCESS FLOW DIAGRAM

DRAWING NUMBER
8 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

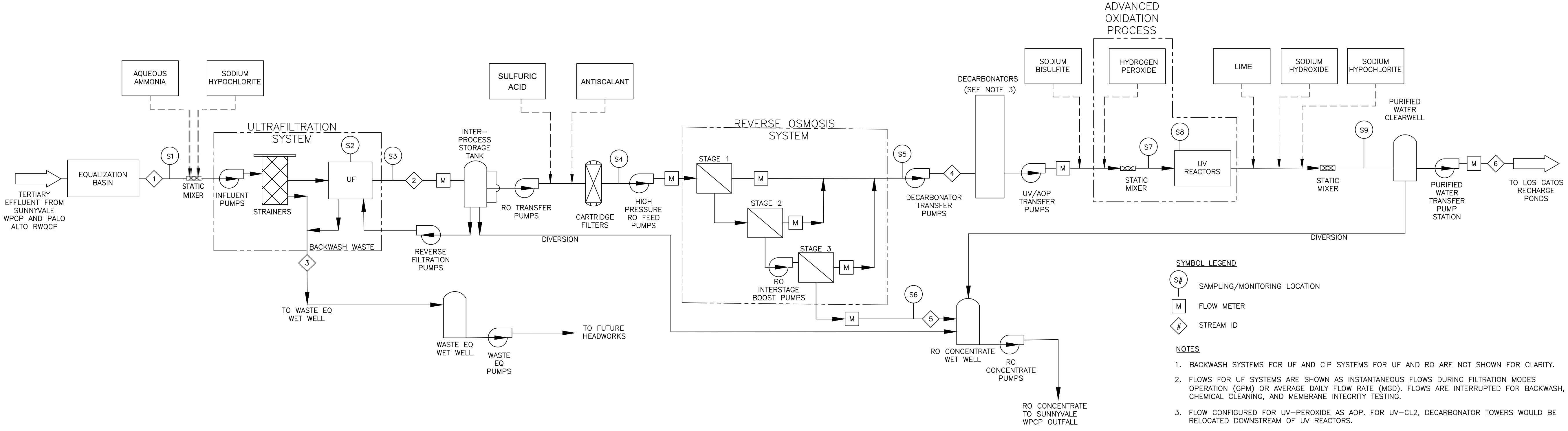
GENERAL

SUNNYVALE 24.5 MGD
COMBINED REGIONAL AWPF

PORTFOLIO 2B

DRAWING NUMBER

9 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

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◇3	2.50	1,700
◇4	24.5	17,000
◇5	4.32	3,000
◇6	24.5	17,000

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

GENERAL

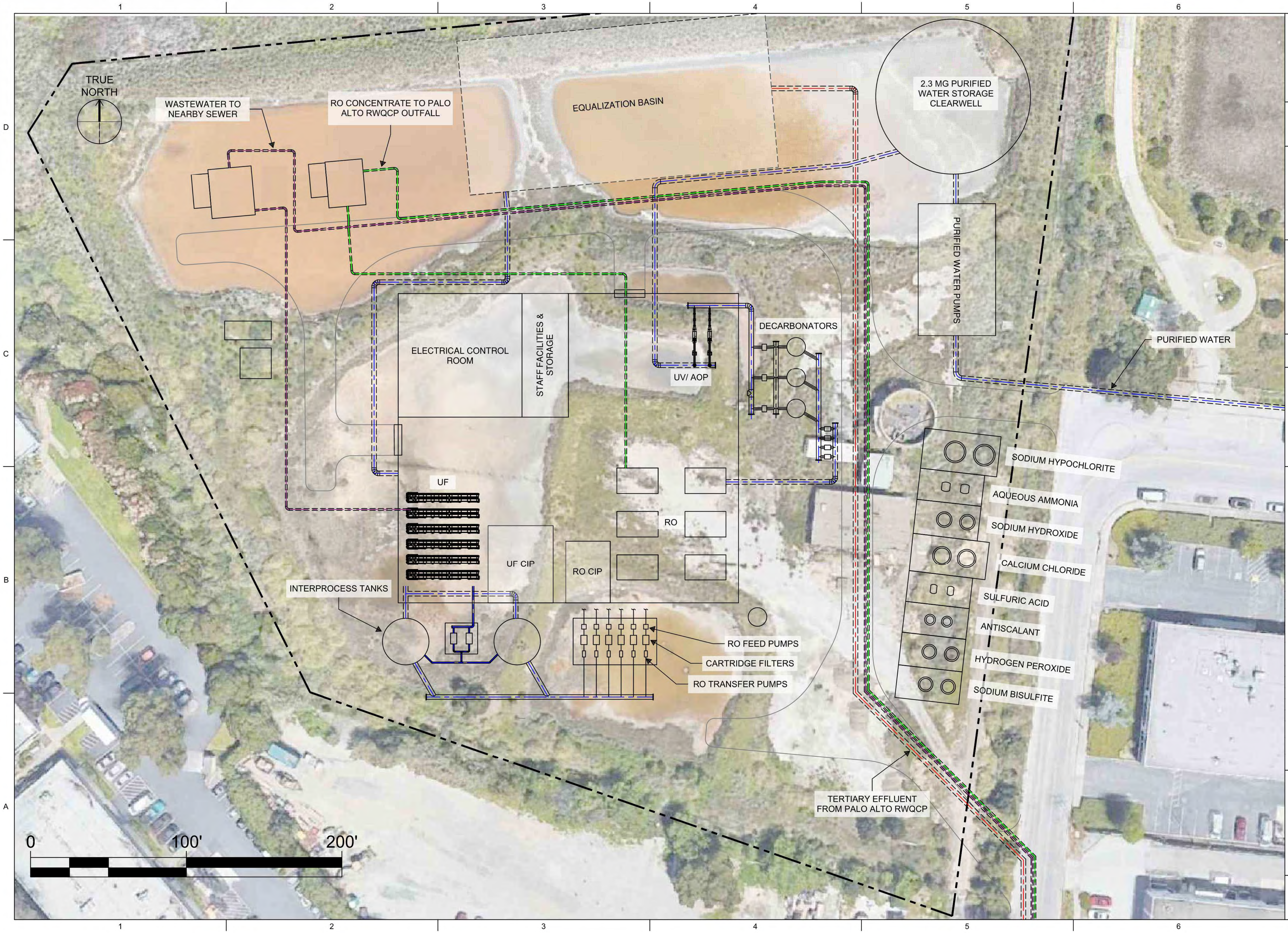
SUNNYVALE 24.5 MGD COMBINED REGIONAL AWPF

PORTFOLIO 2B

PROCESS FLOW DIAGRAM

DRAWING NUMBER

10 OF 23



Palo Alto 24 mgd (2a) For Mark.jpg

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SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

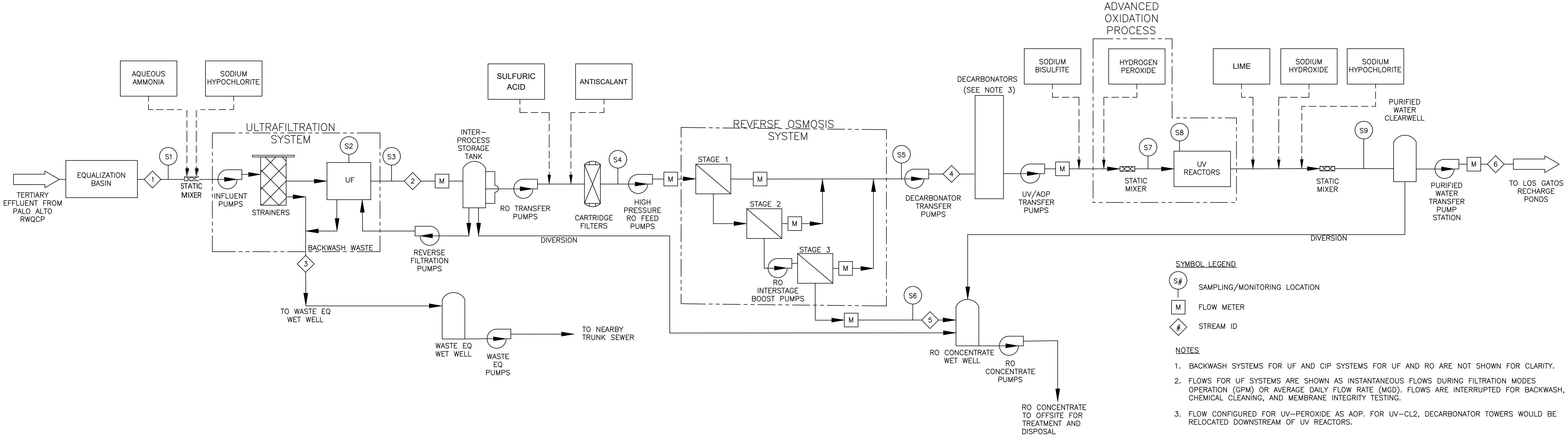
GENERAL

PALO ALTO 14 MGD REGIONAL AWPF

PORTFOLIO 4A

DRAWING NUMBER

11 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

NOTES

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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇1	17.9	12,400
◇2	16.5	11,400
◇3	1.43	1,000
◇4	14.0	9,700
◇5	2.47	1,700
◇6	14.0	9,700

Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

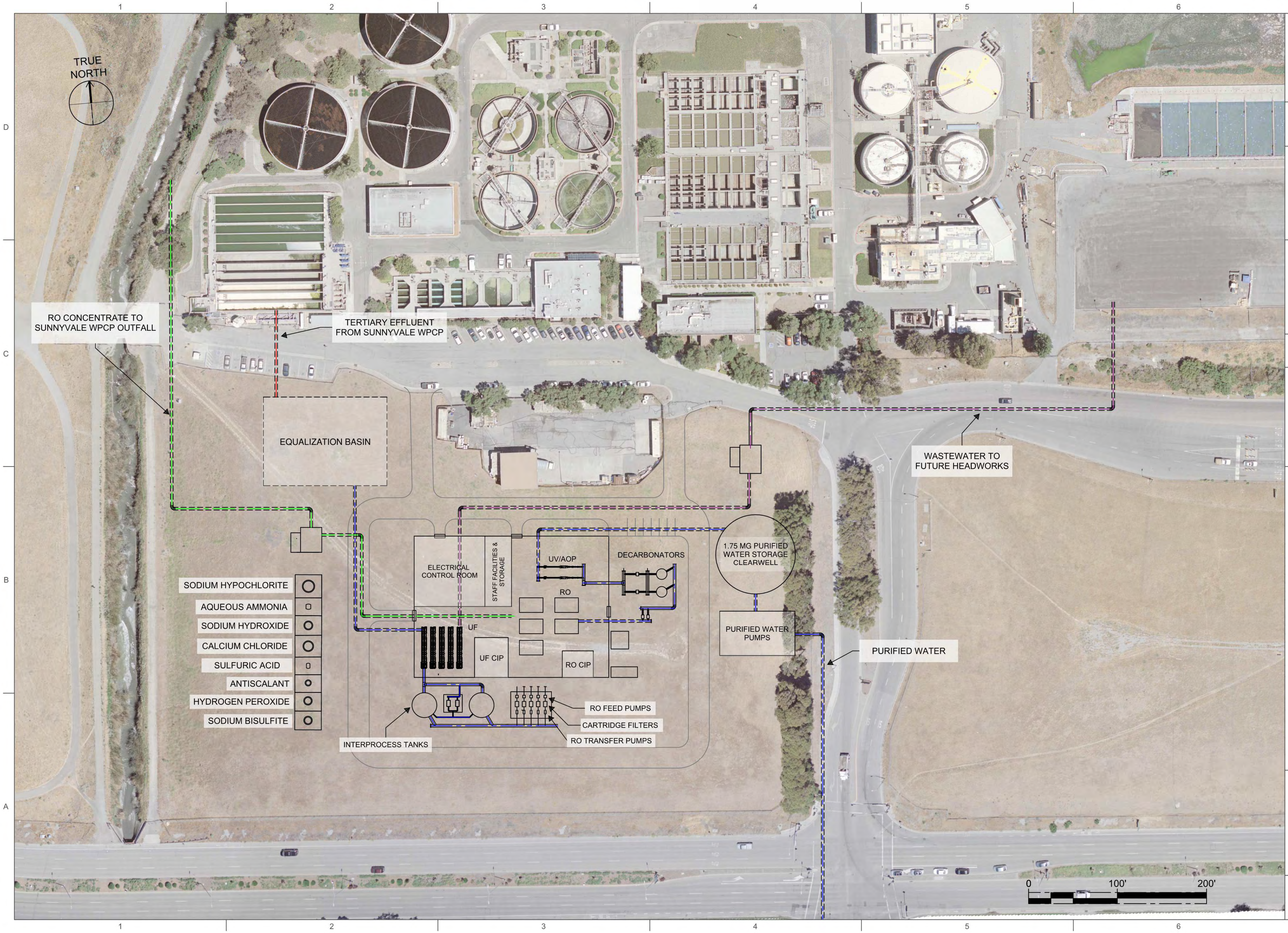
GENERAL

PALO ALTO 14 MGD
REGIONAL AWPF

PORTFOLIO 4A

PROCESS FLOW DIAGRAM

DRAWING NUMBER
12 OF 23



SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

GENERAL

SUNNYVALE 10.5 MGD REGIONAL AWPF

PORTFOLIO 4B

DRAWING NUMBER

13 OF 23

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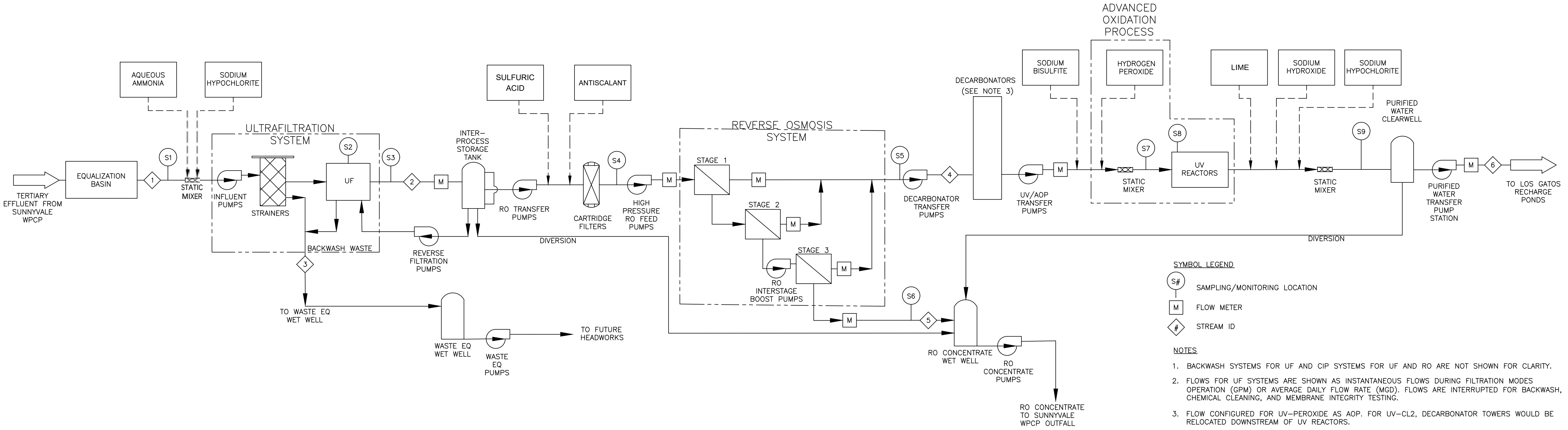

SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
#	STREAM ID

NOTES

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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	13.4	9,300
2	12.3	8,600
3	1.07	700
4	10.5	7,300
5	1.85	1,300
6	10.5	7,300

Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

GENERAL

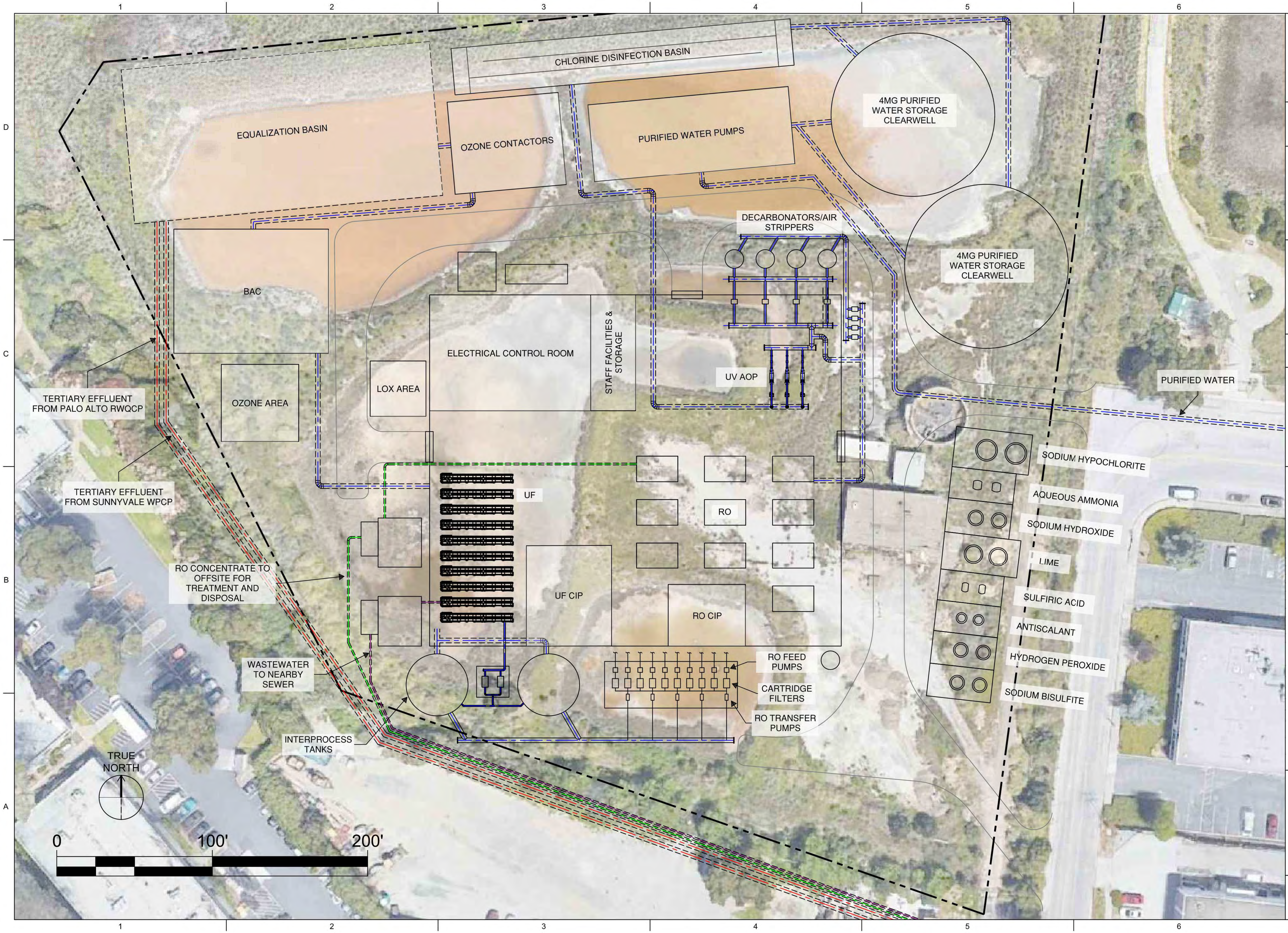
SUNNYVALE 10.5 MGD REGIONAL AWPF

PORTFOLIO 4B

PROCESS FLOW DIAGRAM

DRAWING NUMBER

14 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY WATER DISTRICT

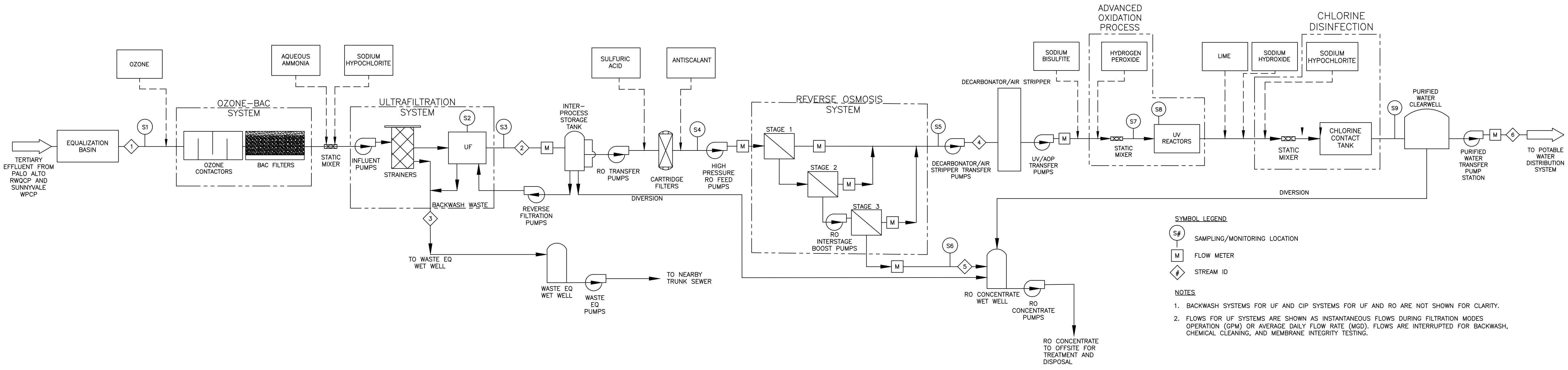
COUNTYWIDE WATER REUSE MASTER PLAN

Valley Water

WESTSIDE TWA SCENARIO WITH AWPF IN PALO ALTO

DRAWING NUMBER

15 OF 23



SYMBOL LEGEND

S#	SAMPLING/MONITORING LOCATION
M	FLOW METER
◇#	STREAM ID

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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS

STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
◇1	31.3	21,700
◇2	28.8	20,000
◇3	2.5	1,700
◇4	24.5	17,000
◇5	4.3	3,000
◇6	24.5	17,000

SANTA CLARA VALLEY WATER DISTRICT

COUNTYWIDE WATER REUSE MASTER PLAN

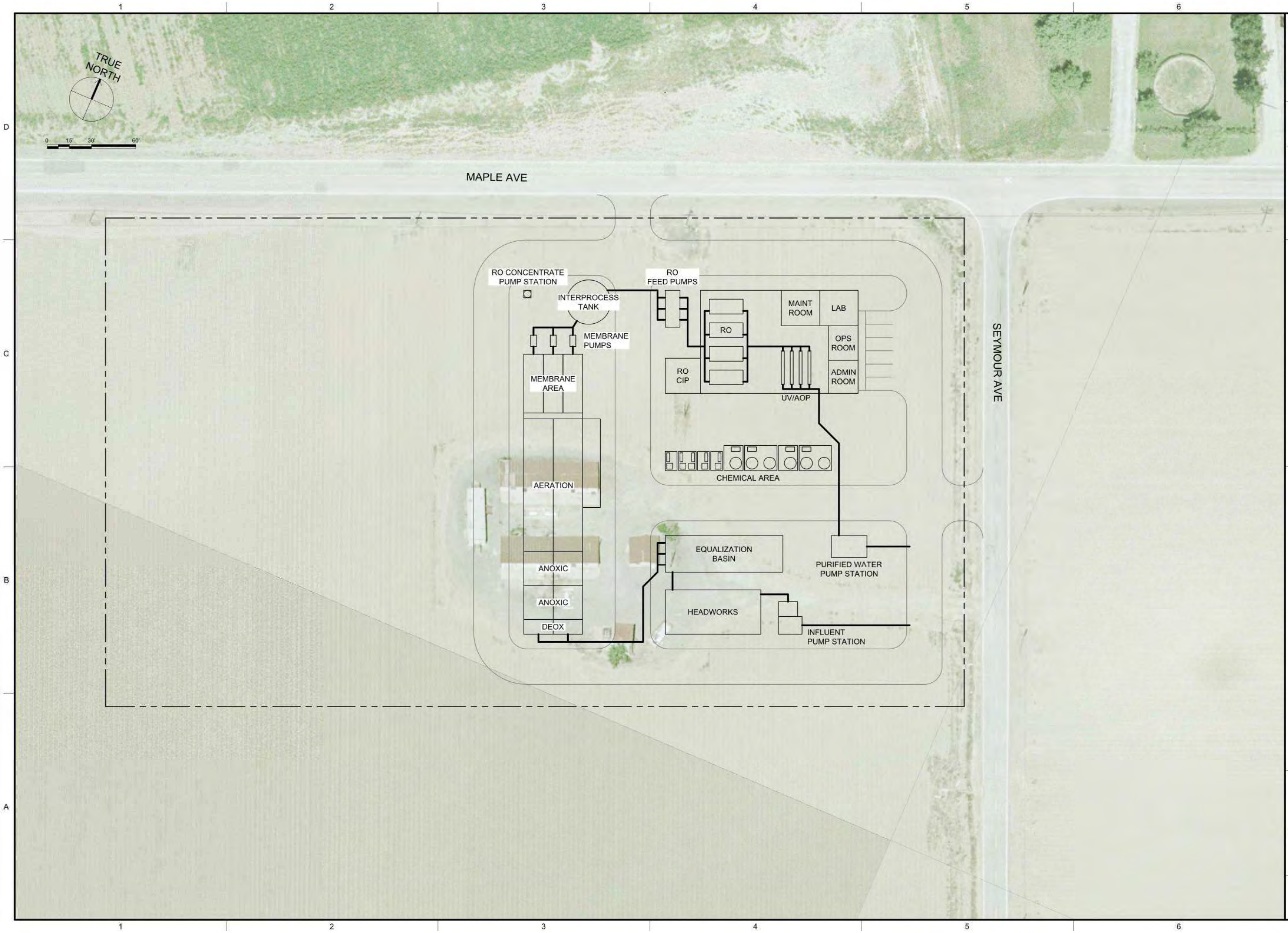
GENERAL

WESTSIDE TWA SCENARIO

PROCESS FLOW DIAGRAM

DRAWING NUMBER

16 OF 23



Brown AND Caldwell

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

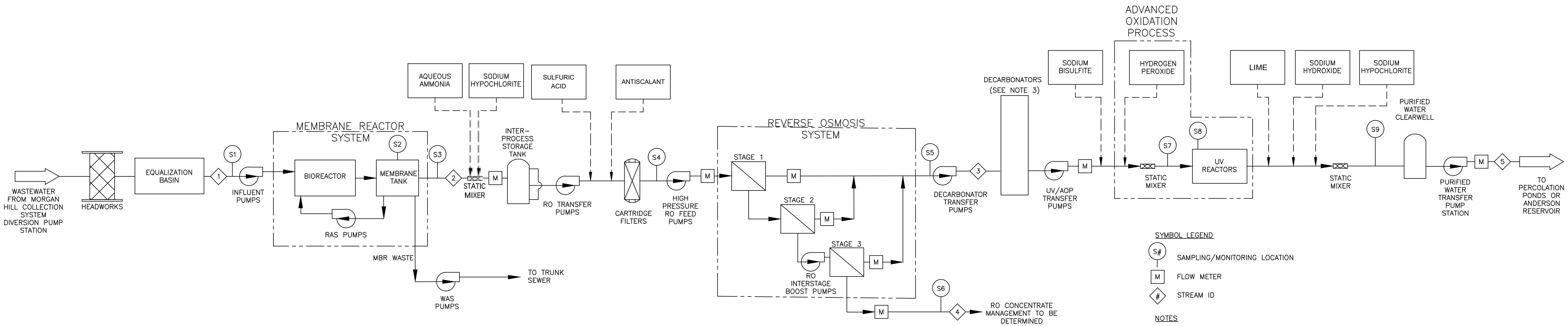
Valley Water

GENERAL

MORGAN HILL 2.5 MGD AWPF

DRAWING NUMBER

17 OF 23



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PROCESS FLOW DIAGRAM

NOT TO SCALE

PROCESS DESIGN FLOWS		
STREAM ID	DESIGN FLOW (MGD)	DESIGN FLOW (GPM)
1	2.5	1,700
2	2.5	1,700
3	2.1	1,500
4	0.38	300
5	2.1	1,500

SANTA CLARA VALLEY
WATER DISTRICT

COUNTYWIDE WATER
REUSE MASTER PLAN

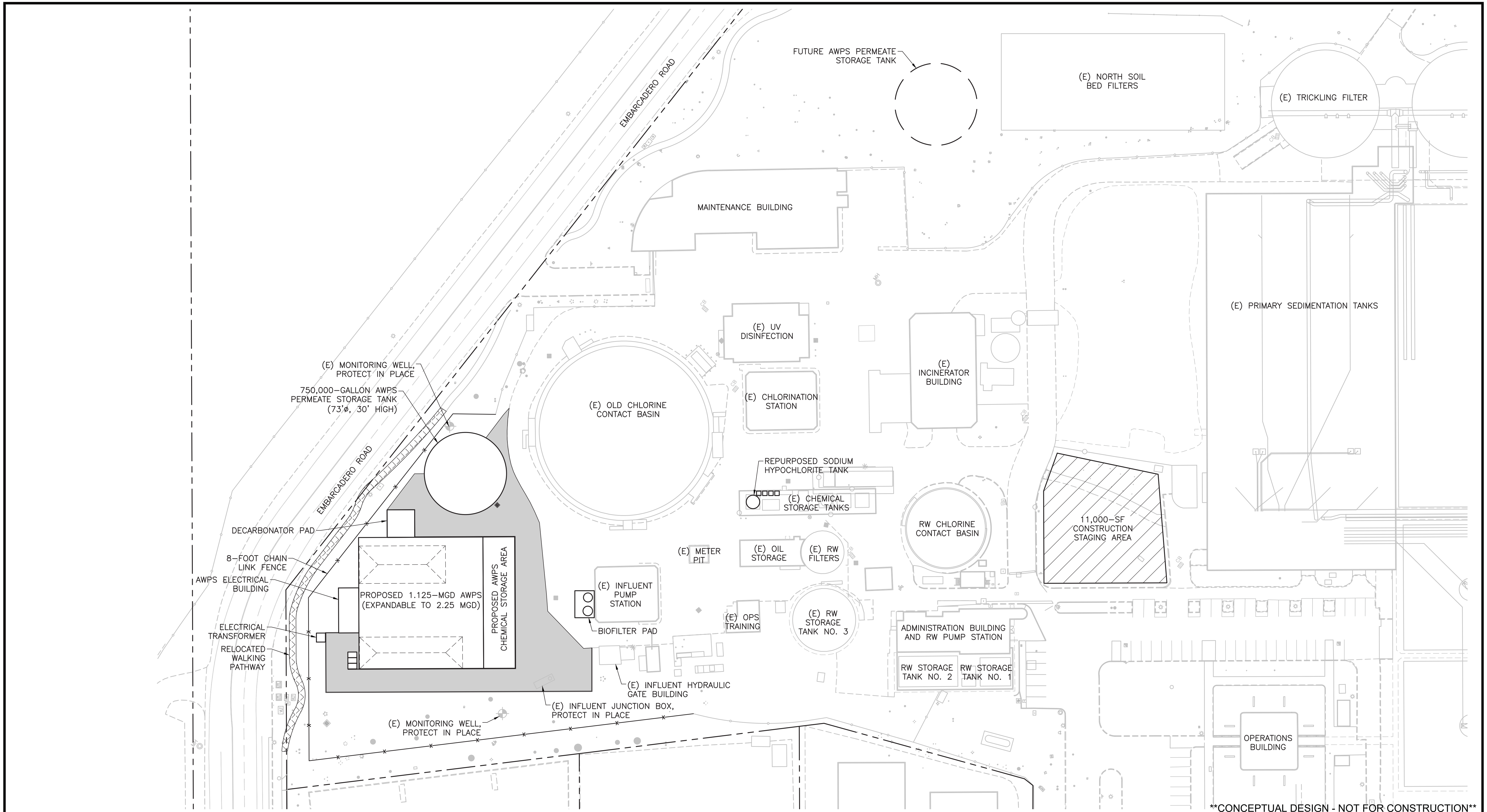
GENERAL

MORGAN HILL 2.5 MGD
AWPF

PROCESS FLOW DIAGRAM

DRAWING NUMBER

18 OF 23

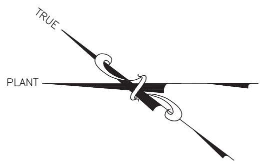

FUTURE AWPS PERMEATE STORAGE TANK
(E) NORTH SOIL BED FILTERS
(E) TRICKLING FILTER
EMBARCADERO ROAD
MAINTENANCE BUILDING
(E) PRIMARY SEDIMENTATION TANKS
(E) UV DISINFECTION
(E) INCINERATOR BUILDING
(E) MONITORING WELL, PROTECT IN PLACE
750,000-GALLON AWPS PERMEATE STORAGE TANK (73'ø, 30' HIGH)
(E) OLD CHLORINE CONTACT BASIN
(E) CHLORINATION STATION
REPURPOSED SODIUM HYPOCHLORITE TANK
(E) CHEMICAL STORAGE TANKS
EMBARCADERO ROAD
RW CHLORINE CONTACT BASIN
11,000-SF CONSTRUCTION STAGING AREA
DECARBONATOR PAD
(E) METER PIT
(E) OIL STORAGE
(E) RW FILTERS
8-FOOT CHAIN LINK FENCE
AWPS ELECTRICAL BUILDING
PROPOSED 1.125-MGD AWPS (EXPANDABLE TO 2.25 MGD)
PROPOSED AWPS CHEMICAL STORAGE AREA
(E) INFLUENT PUMP STATION
(E) OPS TRAINING
(E) RW STORAGE TANK NO. 3
ADMINISTRATION BUILDING AND RW PUMP STATION
ELECTRICAL TRANSFORMER
BIOFILTER PAD
RELOCATED WALKING PATHWAY
RW STORAGE TANK NO. 2
RW STORAGE TANK NO. 1
(E) INFLUENT HYDRAULIC GATE BUILDING
(E) INFLUENT JUNCTION BOX, PROTECT IN PLACE
(E) MONITORING WELL, PROTECT IN PLACE
OPERATIONS BUILDING

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

LEGEND

— — —	PROPERTY LINE	—×—	PROPOSED CHAIN LINK FENCE
——	EXISTING RWQCP FACILITY	——	PROPOSED AWPS FACILITY
- - -	EXISTING EDGE OF PAVEMENT	▨	PROPOSED PAVEMENT
—○—	EXISTING FENCELINE	▨	RELOCATED WALKING PATHWAY
●	EXISTING TREE		

811
Know what's below.
Call before you dig.



PROPERTY LINES ARE APPROXIMATE

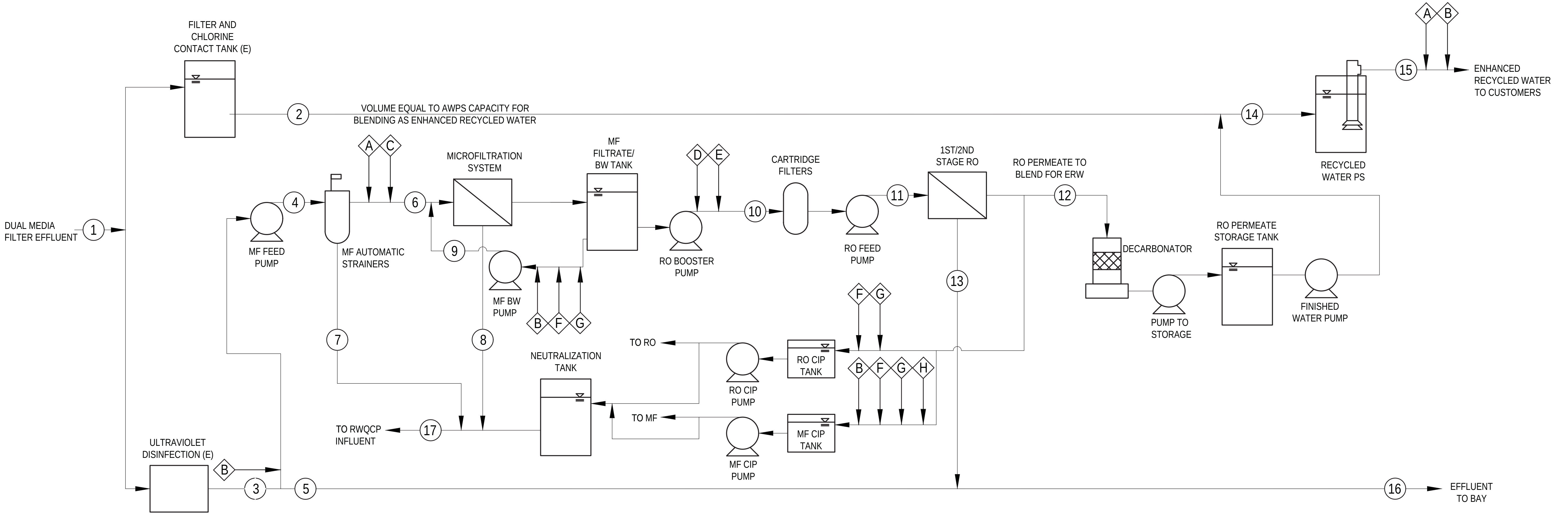
40' 20' 0' 20' 40'
1 inch = 40 ft.

MNS ENGINEERS INC
ENGINEERING | SURVEYING
CONSTRUCTION MANAGEMENT

111 N. Market Street
Suite 440
San Jose, CA 95113
408.610.4202 Phone

GHD

DESIGNED BY NEP				
DRAWN BY SPP	REV.	DATE	DESCRIPTION	BY / APP
CHECKED BY JA	SITE LAYOUT PLAN			PUBLIC WORKS DEPT. RWQCP SCALE: AS SHOWN
APPV'D BY	CITY OF PALO ALTO CALIFORNIA ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. C2



	DUAL MEDIA FILTER EFFLUENT	TERTIARY WATER FOR BLENDING AS ERW	RWQCP FINAL EFFLUENT TO BAY	FEED TO AWPS STRAINERS	REMAINING FINAL EFFLUENT FOR DISCHARGE TO BAY	MF FEED	STRAINERS BWW	MF BWW TO RWQCP INFLUENT	MF BACKWASH FLOW	RO LOW PRESSURE FEED	RO HIGH PRESSURE FEED	RO PERMEATE	RO CONCENTRATE	BLENDED ENHANCED RECYCLED WATER	ENHANCED RECYCLED WATER TO CUSTOMERS	FINAL EFFLUENT TO BAY	PROCESS WASTE TO HEADWORKS
PROCESS STREAM ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RECOVERY (%)						99.5%				93%		85%					
AVERAGE DESIGN FLOW (GPM)	14097	1563	12535	1986	10549	1976	NA	138	1573	1838	1838	1562	276	3125	3125	10825	138
AVERAGE DESIGN FLOW (MGD)	20.3	2.25	18.1	2.86	15.2	2.85	0.01	0.20	NA	2.65	2.65	2.25	0.40	4.50	4.50	15.59	0.20
PRESSURE (PSI)	<20	<20	<20	30–50	<20	30–45	ATM	ATM	30	30	125	10	15–30	<20	65–70	ATM	ATM

CHEMICAL	STREAM	PURPOSE
AQUEOUS AMMONIA	A	CHLORAMINE ADDITION
SODIUM HYPOCHLORITE	B	DISINFECTION/CHLORAMINES, MF MEMBRANE CLEANING
COAGULANT	C	MF PRETREATMENT
SULFURIC ACID	D	RO PRETREATMENT PH ADJUSTMENT
THRESHOLD INHIBITOR	E	RO ANTISCALANT
CITRIC ACID	F	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM HYDROXIDE	G	MF/RO MEMBRANE CLEANING, MF BACKWASH
SODIUM BISULFITE	H	MF CIP WASTE NEUTRALIZATION

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

NO SCALE

811
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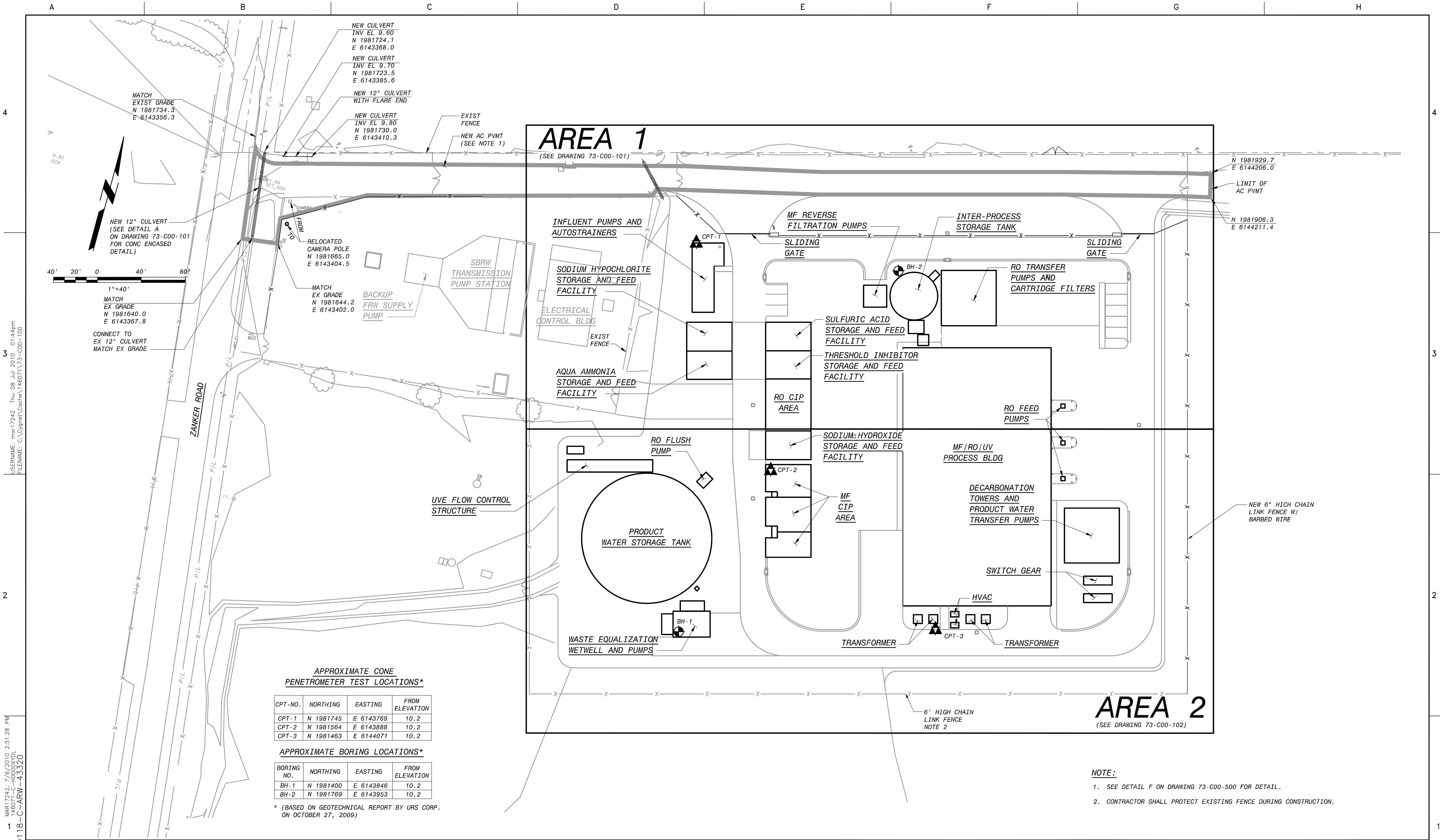
San Jose, CA 95110
408.573.6421 Phone

GHD

DESIGNED BY NEP					
DRAWN BY	REV.	DATE	DESCRIPTION	BY	APP
CHECKED BY JA	PROPOSED AWPS FACILITY PROCESS FLOW DIAGRAM 2.25 MGD CAPACITY			PUBLIC WORKS DEPT. RWQCP SCALE: AS SHOWN	
APPV'D BY	CITY OF PALO ALTO CALIFORNIA ADVANCED WATER PURIFICATION SYSTEM PRELIMINARY DESIGN			SHEET NO. G2	



APPROXIMATE CONE PENETROMETER TEST LOCATIONS*

CPT-NO.	NORTHING	EASTING	FROM ELEVATION
CPT-1	N 1981745	E 6143769	10.2
CPT-2	N 1981564	E 6143888	10.2
CPT-3	N 1981463	E 6144071	10.2

APPROXIMATE BORING LOCATIONS*

BORING NO.	NORTHING	EASTING	FROM ELEVATION
BH-1	N 1981400	E 6143846	10.2
BH-2	N 1981769	E 6143953	10.2

* (BASED ON GEOTECHNICAL REPORT BY URS CORP. ON OCTOBER 27, 2009)

NOTE:

1. SEE DETAIL F ON DRAWING 73-C00-500 FOR DETAIL.
2. CONTRACTOR SHALL PROTECT EXISTING FENCE DURING CONSTRUCTION.

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REV	DESCRIPTION	DATE	APPR.
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BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	07/02/10
DESIGN	DCL/BGP
DRAWN	BGP
CHECKED	RDR

ENGINEERING CERTIFICATION
DANIEL C. LOPEZ
No. C 054330
Exp. 12/31/11
CIVIL
Daniel C. Lopez
07/02/10

SOUTH BAY
WATER RECYCLING

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY

CIVIL
SITE LAYOUT

SCALE
1"=40'

VERIFY SCALES
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PROJECT NUMBER
91184008

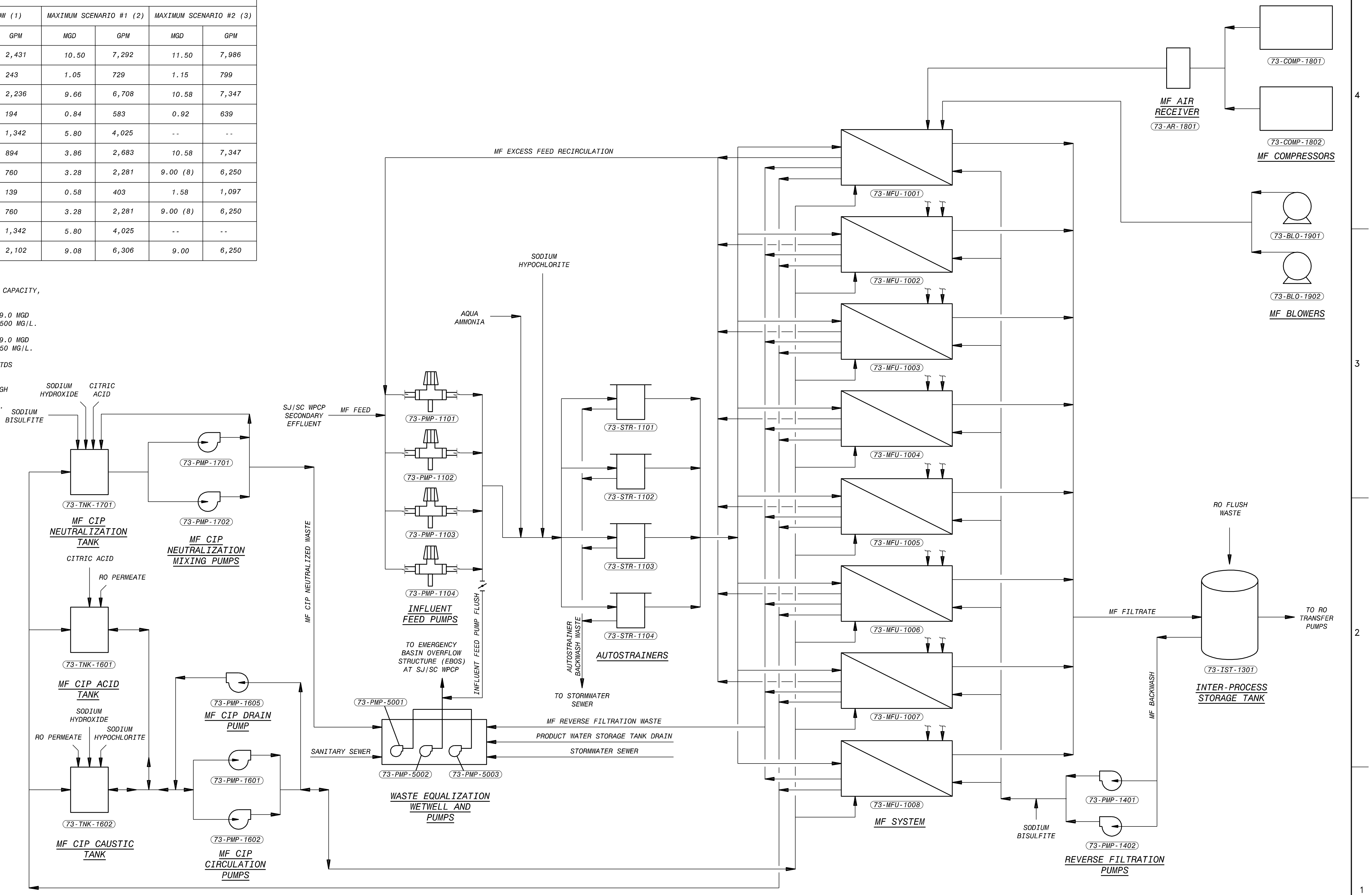
SHEET CODE:
B&V 73-C00-100
CITY
DISTRICT
15 OF 261

PROCESS DESIGN FLOWS

	MINIMUM FLOW (1)		MAXIMUM SCENARIO #1 (2)		MAXIMUM SCENARIO #2 (3)	
STREAM NAME	MGD	GPM	MGD	GPM	MGD	GPM
MF FEED WATER (4)	3.50	2,431	10.50	7,292	11.50	7,986
MF EXCESS FEED RECIRCULATION (7)	0.35	243	1.05	729	1.15	799
MF FILTRATE (5)	3.22	2,236	9.66	6,708	10.58	7,347
MF BACKWASH	0.28	194	0.84	583	0.92	639
RO BYPASS	1.93	1,342	5.80	4,025	--	--
RO FEED	1.29	894	3.86	2,683	10.58	7,347
RO PERMEATE (6)	1.09	760	3.28	2,281	9.00 (8)	6,250
RO CONCENTRATE	0.20	139	0.58	403	1.58	1,097
UV FEED (RO PERMEATE)	1.09	760	3.28	2,281	9.00 (8)	6,250
UV FEED (RO BYPASS)	1.93	1,342	5.80	4,025	--	--
FINAL TREATED EFFLUENT	3.03	2,102	9.08	6,306	9.00	6,250

NOTES

1. THE MINIMUM FLOW IS BASED ON A 3.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 500 MG/L.
2. THE MAXIMUM FLOW, SCENARIO #1 IS BASED ON A 9.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 500 MG/L.
3. THE MAXIMUM FLOW, SCENARIO #2 IS BASED ON A 9.0 MGD ARWTF CAPACITY, WITH A PRODUCT WATER TDS OF 50 MG/L. THIS SCENARIO ASSUMES BLENDING WITH TERTIARY EFFLUENT FROM THE WPCP TO ACHIEVE A BLENDED TDS OF 500 MG/L.
4. ASSUMES NO EXCESS FEED RECIRCULATION, ALTHOUGH PROVISIONS WILL BE PROVIDED IN THE EVENT THIS IS NEEDED BY THE MF SYSTEM.
5. ASSUMES MF RECOVERY OF 92 PERCENT.
6. ASSUMES RO RECOVERY OF 85 PERCENT.
7. APPROXIMATELY 10 PERCENT OF THE MF FEED WATER WILL BE RECIRCULATED TO THE SUCTION OF THE INFLUENT FEED PUMPS.
8. THE INITIAL RO SYSTEM DESIGN IS BASE ON A PRODUCTION OF 8.0 MGD. THE RO SYSTEM IS EXPANDABLE TO 9.0 MGD.



REV	DESCRIPTION	DATE	APPR.
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BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	07/02/10
DESIGN	DCL
DRAWN	JMM
CHECKED	RDR

ENGINEERING CERTIFICATION
DANIEL C. LOPEZ
No. C 054330
Exp. 12/31/11
CIVIL
Daniel C. Lopez
07/02/10

SOUTH BAY
WATER RECYCLING
CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY
GENERAL
PROCESS FLOW DIAGRAM (SHEET 1 OF 2)

SCALE
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PROJECT NUMBER
91184008
SHEET CODE:
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8 OF 261

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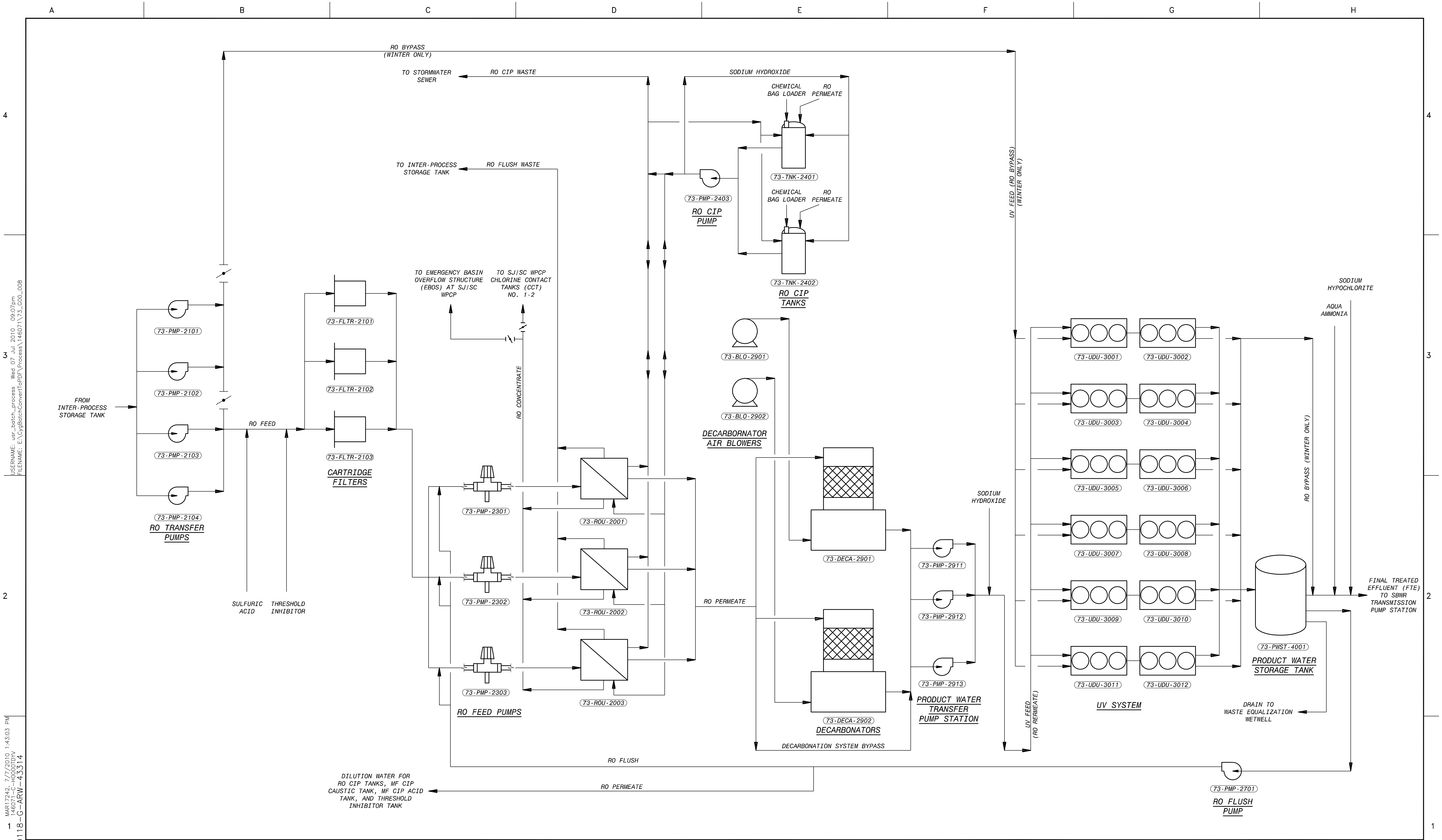

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BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE	07/02/10
DESIGN	MNT
DRAWN	JMM
CHECKED	RDR

ENGINEERING CERTIFICATION
No. C 054330
Exp. 12/31/11
07/02/10

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITY

GENERAL
PROCESS FLOW DIAGRAM (SHEET 2 OF 2)

SCALE: NONE
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PROJECT NUMBER: 91184008
SHEET CODE: B&V 73-G00-008
CITY
DISTRICT
9 OF 261

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Appendix A-5: Basis of Cost

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Table of Contents

Section 1: Introduction ... 1
1.1 Previous Work ... 1
1.2 Class of Estimate ... 1
1.3 Cost Development ... 1
1.4 Construction Cost Divisions ... 2
Section 2: Project Elements ... 3
2.1 Advanced Water Purification Facilities ... 3
  2.1.1 Equipment ... 4
  2.1.2 Mobilization/Demobilization ... 4
  2.1.3 Site Work ... 4
  2.1.4 Property and Easements ... 5
  2.1.5 Concrete ... 5
  2.1.6 Buildings ... 5
  2.1.7 Chemical Facilities ... 5
  2.1.8 Piping, Fitting, and Valves ... 5
  2.1.9 Electrical and Instrumentation ... 5
2.2 Pump Stations ... 6
2.3 Conveyance Pipelines ... 7
Section 3: Capital Costs ... 8
3.1 Raw Construction Costs ... 8
3.2 Contractor and Other Markups ... 8
3.3 Implementation Costs ... 9
Section 4: Operations and Maintenance Costs ... 10
4.1 O&M Cost Components ... 10
  4.1.1 Labor ... 10
  4.1.2 Electricity ... 10
  4.1.3 Consumables ... 11
4.2 AWPF ... 12
4.3 Pipeline ... 12
4.4 Pump Station ... 13
4.5 Recharge Ponds ... 13
4.6 NPR Distribution System ... 13
Section 5: Replacement and Renewal Costs ... 13
Section 6: Water Supply Costs ... 16
Section 7: Life-cycle Cost Evaluation ... 17
Exhibit 1: AWPF Unit Costs ... 19
Exhibit 2: R&R Values Used from Valley Water ... 29

List of Tables

Table 1. Construction Cost Divisions and Assumptions........ 2
Table 2. Site Work Assumptions for AWPFs........ 4
Table 3. Concrete Unit Costs........ 5
Table 4. Attributes of Pump Stations for Potable Reuse........ 6
Table 5. Conveyance Unit Cost Estimates........ 7
Table 6. Contractor and Other Markups........ 9
Table 7. Implementation Cost Factors........ 10
Table 8. Labor Costs........ 10
Table 9. Electric Rates at Potential Facilities........ 11
Table 10. Chemical Costs........ 11
Table 11. Advanced Treatment Major Consumables........ 12
Table 12. Replacement and Renewal Cycles by Asset Class........ 15
Table 13. Source Flow Assumptions........ 16
Table 14. Annual Source Flow by Portfolio........ 16
Table 15. Life-cycle Factors and Assumptions........ 17
Table 16. References for Economic Comparison of Life Cycles........ 18

Section 1: Introduction

This Basis of Cost summary documents the approach and factors used to develop the estimated capital and operations and maintenance (O&M) costs for the Santa Clara Valley Water District's (Valley Water) *Countywide Water Reuse Master Plan* (CoRe Plan). The basis of cost documents the capital, O&M, replacement and renewal (R&R), and life-cycle costs to evaluate and compare project elements and portfolios. It does not attribute costs or benefits to payers and beneficiaries.

1.1 Previous Work

Valley Water and the Partner Agencies have developed many relevant studies and plans that are now serving as a foundation for the CoRe Plan. While the past studies are invaluable in many respects, the basis of costs often varies between projects as a function of scope, cost estimating approach, level of detail, and available cost data. Cost estimates should provide a common basis to enable meaningful comparisons among alternatives or portfolios.

In 2018, Valley Water completed the *Expedited Purified Water Program Plan* (Program Plan), which developed and evaluated a range of potable reuse options. The Program Plan involved developing preliminary designs and cost estimates of potential advanced water purification facilities (AWPF) and conveyance facilities, including some that are still being explored under the CoRe Plan, such as a 24 million gallons per day (mgd) AWPF at San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF), infrastructure improvements at Los Gatos Recharge Ponds (LGRP) for groundwater recharge (GWR), and a connection to Penitencia Water Treatment Plant (WTP) for raw water augmentation (RWA). To support comparison of costs and an economic assessment, the CoRe Plan uses an approach consistent with the 2017 *Program Plan Basis of Cost Estimating* memorandum for estimating costs of potable reuse elements.

For non-potable reuse (NPR), the approach for cost estimating relies on the Partner Agencies' recycled water master plans, which describe plans for NPR distribution system expansions and provide associated cost estimates. Costs from existing plans were escalated to current value based on Engineering News-Record (ENR) Construction Cost Index (CCI).

1.2 Class of Estimate

The cost estimates align with the Association for the Advancement of Cost Engineering (AACE) International's criteria for Class 5 estimates, except for cost estimates for AWPFs, which align with Class 4. Expected accuracy for Class 5 estimates typically ranges from -50 percent to +100 percent, while expected accuracy for Class 4 estimates typically ranges from -30 to +50 percent.

1.3 Cost Development

BC prepared the cost estimates using a Windows-based commercial estimating software engine, BC's material and labor database, historical project data, current vendor and material cost information, and other cost benchmarks specific to the project locale. The estimates reflect capital costs (i.e., construction, equipment, contractor, and relevant markups), as well as O&M and R&R costs. Labor rates reflect burdens such as salary and benefits. Trade discounts were not considered.

As is customary practice in a planning-level design, reference documents and available information lacked some details, resulting in the estimator's use of the following assumptions:

1. Equipment rental rates are based on verifiable pricing from the local project area rental yards, Blue Book rates, and/or rates contained in BC's estimating database.

2. Contractor markup is based on conventionally accepted values and adjusted for project-area economic factors.
3. Major equipment costs are based on Silicon Valley Advanced Water Purification Center (SVAWPC) facility costs and vendor-supplied price quotes obtained by BC engineers.
4. Bulk material quantities are based on manual quantity take-offs.
5. Sufficient electrical power is available to feed equipment specified in the preliminary designs. The local power company will supply power and transformers suitable for the potential facilities. (Note: If eligible for Power and Water Resources Pooling Authority [PWRPA] rates, there is potential for lower power costs. The use of PWRPA should be considered during the design phase when location and size of the improvements are further defined.)
6. Soils are of adequate nature to support the structures.

1.4 Construction Cost Divisions

The Construction Specifications Institute's MasterFormat provides construction divisions, the most widely used standard for organizing written information for commercial and institutional building projects in the U.S. and Canada. The original format is based on 16 divisions. In 2004, MasterFormat was updated and expanded to 50 divisions.

The CoRe Plan's detailed cost estimates are presented in the current 50-division system and in the original 16-division system (when adopting the structure of cost estimates from the 2017 Program Plan). Each asset was assigned a specification division (e.g., general, sitework, concrete) and quantity that were used to structure estimated costs obtained from manufacturers, past projects, and/or industry resources. Table 1 presents a list of general assumptions by division.

Table 1. Construction Cost Divisions and Assumptions

Division	Division (2017 Program Plan)	Assumptions
01 – General requirements	01 - General Requirements	• General requirements of 10% design account for mobilization/demobilization, supervision, temporary utilities and facilities.
03 - Concrete	03 - Concrete	• All concrete is included as 5,000 pounds per square inch (psi) and 4,000 psi for equipment pad. • Concrete slab on grade, walls, and suspended slab reinforcing steel is included at 200 pounds per cubic yard (lb/yd^3) for all structures. Equipment pads reinforcing steel is included at 150 lb/yd^3 for all structures. • Epoxy-coated rebar is not included for any structures.
05 - Metals	05 - Metals	• A lump-sum allowance for metals is included.
09 - Finishes	09 - Finishes	• A lump-sum allowance for painting and coatings is included.
17 - Instrumentation	17 - Instrumentation	• An allowance of 25% of electrical costs is included.
26 – Electrical	16 – Electrical	• Electrical distribution costs are based on the pumps and motors listed in flow diagrams and piping and instrumentation diagrams. • An allowance for new electrical service is included. • An allowance of 30% of equipment costs is included.

Table 1. Construction Cost Divisions and Assumptions

Division	Division (2017 Program Plan)	Assumptions
31 - Earthwork	02 - Sitework	• Structural excavation and backfill costs are based on professional judgment regarding structure depths. The excavation cost reflects soil excavation. • Includes pipelines, casing, sheeting and shoring, and potholing. • An allowance is included for landscaping, lighting and security, and site dewatering. • Subgrade structural piles are included for AWPF facilities at Palo Alto, Sunnyvale, and San José sites.
32 - Exterior improvements	05 - Metals	• Chain link fence around the facility is included.
40 – Process integration	15 - Mechanical	• An allowance of 30% of equipment costs is included. • An allowance of 5% of piping costs is included for valves, fitting, and supports.
43 - Process gas and liquid handling, purification, and storage	10 – Specialties	• Process building based on per-square-foot unit cost is included. • Chemical storage and tank costs are included.
46 – Water and wastewater equipment	11 – Equipment	• Equipment costs include ultraviolet (UV) treatment, reverse osmosis (RO), decarbonator, UV system, pumps, and tanks.

Section 2: Project Elements

This section introduces the costing methods and assumptions for the CoRe Plan's project elements and principal cost components:

- AWPFs
- Pump stations
- Conveyance pipelines
- NPR distribution system expansion
- Delivery point improvements (i.e., Los Gatos Recharge Ponds and Penitencia WTP improvements)

2.1 Advanced Water Purification Facilities

AWPFs represent a substantial portion of purified water program costs. The cost of the facilities depends on the quality of source water, type and quantity of purified water, regulatory requirements, process design, site characteristics, and facility characteristics. Facilities planning included development of preliminary process design, design criteria, and site layouts that form the basis for estimating quantities and cost. The proposed AWPFs follow a similar approach used for the existing SVAWPC with modifications based on needs identified by Valley Water.

The following are major assumptions for AWPF estimates:

- AWPFs are considered non-essential facilities and not equipped with standby power or process equipment redundancy for ultrafiltration (UF), RO, or decarbonation processes
- Full advanced treatment required
- Membrane and UV equipment located indoors
- Decarbonator towers, chemical facilities, and pump stations located outdoors
- Certified laboratory facilities excluded but includes a sample preparation area

- Where foundation piles were used for the existing SVAWPC facilities, adjacent proposed AWPF assumed a similar approach for pile supports.
- Facilities sited at “Recycle Hill” in Sunnyvale would require site preparation to remove landfill materials. Costs for excavation, trucking, disposal, and fill were estimated by the City of Sunnyvale in 2016 at between \$30 million and \$38 million. For this estimate, these costs were rounded to \$40 million and escalated to \$43.5 million in 2019 dollars based on ENR CCI.

2.1.1 Equipment

Process and ancillary equipment and installation represent a substantial portion of the raw construction cost for AWPFs. Costs for equipment are based on two sources: scaled SVAWPC costs; and equipment vendor budget proposals customized to influent water quality, desired effluent water quality, and facility plans. Equipment installation costs are estimated as a percentage of equipment costs from vendor proposals and were estimated at 50 percent for process equipment, such as microfiltration, RO, and UV.

2.1.2 Mobilization/Demobilization

Mobilization involves the process of establishing resources at a project site that are to be used over the course of the project, such as temporary office trailers, temporary utilities, and other equipment rental. Mobilization also includes insurance, bonding, administrative submittals, and regulatory permitting like stormwater pollution prevention plans. Demobilization involves removing temporary facilities, trailer(s), and the final move off the construction site. For this project, mobilization/demobilization is estimated as 10 percent of the sum of raw construction cost and categorized under Division 1 – General.

2.1.3 Site Work

Site work includes work related to the civil construction of facilities. The associated costs for the major elements are based on unit costs from RSMeans and quantity estimates based on facility drawings and construction assumptions.

Table 2 presents assumptions for site work used to determine AWPF cost estimates.

Table 2. Site Work Assumptions for AWPFs

Item	Value	Measurement	Unit
Slab	2	Depth	ft
Wall	1.5	Width	ft
Chemical Wall	8	Width	in.
Chemical Wall	56	Depth	in.
Paved – Asphalt	4	Depth	in.
Paved - Ag Base	12	Depth	in.
Paved – Backfill	0	Depth	in. (already 3 ft of backfill to raise site)
Unpaved – Gravel	4	Depth	in.
Unpaved - Ag Base	12	Depth	in.
Unpaved – Backfill	0	Depth	in. (already 3 ft of backfill to raise site)
Slab on Grade - Ag Base	12	Depth	in.
Depth of Compaction	1.5	Depth	ft

2.1.4 Property and Easements

The AWPF cost estimations do not assume the purchase of private property.

2.1.5 Concrete

Table 3 presents assumptions for concrete unit costs used to determine AWPF cost estimates.

Table 3. Concrete Unit Costs

Concrete Setting	Installed Unit Cost ($/CY)	Source
Slab on grade	$800	Sage Accounting, 2019
Suspended slab	$1,500	Sage Accounting, 2019
Wall (cast in place)	$1,000	Sage Accounting, 2019

2.1.6 Buildings

Membrane and UV process equipment for the AWPFs are assumed to be enclosed in pre-engineered buildings similar to the SVAWPC. Building costs include HVAC and fire suppression for structures. Additional building space is necessary for O&M staff, storage, sample preparation, and other support functions. Process building costs are based on SVAWPC costs.

2.1.7 Chemical Facilities

Chemical facilities include storage tanks and totes, chemical metering pumps, canopies, and spill containment. Chemical storage quantities are determined as described in the specific facilities plans, then the appropriate storage container and number of metering pumps are selected based on the quantity and specific chemical properties. Costs for storage tanks and totes and metering pumps were obtained from vendor quotes and RSMeans estimates.

2.1.8 Piping, Fitting, and Valves

The AWPF includes both yard and mechanical process piping. All facility piping was estimated based on engineering judgment. Allowance for piping is 30 percent of equipment costs. Allowance for fittings and valves were each estimated as 5 percent of the piping allowance. Estimated costs for conveyance pipelines are presented separately from the AWPF costs.

2.1.9 Electrical and Instrumentation

Space allocations were incorporated into the AWPF building for an electrical room and operations room; however, electrical and instrumentation-specific details (i.e., electrical service, duct banks, motor control center, instrument monitoring, SCADA, etc.) have not been defined at this facility-planning level. Therefore, allowances are used as a basis for electrical and instrumentation cost estimates. Electrical cost allowance was estimated as 30 percent of the total Division 46 – Water and Wastewater Equipment cost. Instrumentation cost was estimated as 25 percent of the total Division 26 – Electrical cost. Full electrical redundancy for the treatment facilities is not required as the facility is considered non-essential.

2.2 Pump Stations

Pump station costs vary depending on hydraulic requirements, type of pumps, pump station arrangement, surge control systems, and other project characteristics. Pump power assumes 65 percent efficiency and a 10 percent safety factor. Cost estimates are based on the Expedited Purified Water Program.

Table 4 presents attributes and estimated capital costs of pump stations considered in the plan.

Table 4. Attributes of Pump Stations for Potable Reuse

Portfolio/ Option	Pump Station Number	Treatment Level of Water to be Pumped	Start Point	End Point	Flow (gpm)	Total Dynamic Head (ft)	Pump Power (hp)
1a	PS-1	Purified water	San José AWPF	LGRP	16,667	400	2,877
1b	PS-2	Purified water	San José AWPF	Penitencia WTP	16,667	550	3,977
1c	PS-14	Purified water	San José AWPF	Water modulating valve vault at Penitencia WTP	16,667	350	2,500
1c	PS-15	Purified water	San José AWPF	Northside Santa Clara	8,333	250	890
1d	PS-16	Purified water	San José AWPF	Water modulating valve vault at Penitencia WTP	16,667	350	2,500
1d	PS-17	Purified water	San José AWPF	Northside Santa Clara	8,333	250	890
2a	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
2a	PS-4	Effluent	Sunnyvale WPCP	Palo Alto AWPF	8,000	100	400
2a	PS-5	Purified water	Palo Alto AWPF	LGRP	16,667	400	2,877
2b	PS-6	Effluent	Palo Alto RWQCP	Sunnyvale AWPF	12,000	100	508
2b	PS-7	Purified water	Sunnyvale AWPF	LGRP	16,667	400	2,877
4	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
4	PS-9	Purified water	Palo Alto AWPF	LGRP	9,722	400	1,650
4	PS-10	Purified water	Sunnyvale AWPF	LGRP	6,945	400	1,400
West County TWA	PS-3	Effluent	Palo Alto RWQCP	Palo Alto AWPF	12,000	100	508
West County TWA	PS-4	Effluent	Sunnyvale WPCP	Palo Alto AWPF	8,000	100	400
West County TWA	PS-18	Purified water	Palo Alto AWPF	West Pipeline at Stevens Creek	16,667	500	3,570
Morgan Hill[a]							
Option 2	PS-13	Purified water	Morgan Hill Satellite AWPF	San Pedro Ponds	1,458	125	78
Option 3	PS-11	Purified water	Morgan Hill Satellite AWPF	Booster Pump Station	1,458	500	279
Option 3	PS-12	Purified water	Booster Pump Station	Anderson Reservoir	1,458	350	218

a. Portfolios do not include costs for Morgan Hill recycled water alternatives

hp = horsepower

TWA = Treated Water Augmentation

2.3 Conveyance Pipelines

Conveyance includes both purified water and effluent pipelines that feed water into the AWPF. Conveyance estimates are based on costs from the Expedited Purified Water Program and experience implementing projects locally in urban settings with more than 12 feet of cover. The estimate reflects costs for cement-lined ductile iron pipe.

The capital costs for each pipeline include an estimated cost for easements. Easement costs are calculated using an extrapolated unit cost of $32 per linear foot, based on the easement cost estimate of $3 million for Component 1 in the Expedited Purified Water Program. This cost was applied to all pipelines except those included in Portfolio 1b, 1c, and 1d, which used a unit cost of $222 per linear foot based on Component 2 in the Expedited Purified Water Program.

Table 5 presents conveyance unit cost estimates.

Table 5. Conveyance Unit Cost Estimates

Open cut	
Raw installed cost	$20/in-ft
Traffic control	7%
Sheeting and Shoring	7%
Potholing	2%
Total unit cost, open cut	$23.20/in-ft
Bore and jack	
Casing (including launching and receiving pits)	$32/in-ft
Carrier Pipe	$20/in-ft
Total unit cost, bore and jack	$52/in-ft
Microtunneling	
Casing (including launching and receiving pits)	$50/in-ft
Carrier Pipe	$20/in-ft
Total unit cost, microtunneling	$70/in-ft
Horizontal directional drilling	
Total unit cost, horizontal directional drilling (no casing)	$28/in-ft
Pumping	
Horsepower efficiency	65%
Safety Factor	10%
Total unit cost, pumping	$4,000/hp
Easements	
Pipelines except Portfolios 1b, 1c, and 1d	$32/ft
Pipelines in Portfolio 1b, 1c, and 1d	$222/ft

in-ft = inch diameter, feet of pipe

Section 3: Capital Costs

Capital costs consist of:

- Raw construction costs for new treatment and conveyance facilities and expansion of existing NPR distribution systems.
- Markups, including contractor overhead and profit, sales tax, equipment installation cost, and contingency.
- Implementation costs, including change orders, engineering services for design and construction, and construction management (CM). Legal and administrative costs associated with implementation also are incorporated.

The capital cost estimate assumes a design-bid-build implementation approach. Appendix A-6 presents detailed cost estimates, including capital costs for each portfolio.

3.1 Raw Construction Costs

Capital cost estimates rely on estimated construction costs and unit costs developed using RSMeans, vendor quotes, and equipment pricing furnished by either an engineering team or an estimator. The estimate includes equipment and construction-related labor costs and anticipated productivity adjustments to labor. Based on the level of detail available, percentage-based allowances are used for some elements, such as electrical and instrumentation. See Exhibit 1 for a list of unit costs for construction and O&M.

Construction cost factors were used to develop and escalate unit costs when required to reflect the current bid environment, industry trends, and project location. Two factors are incorporated into some of the unit costs, including the following.

- **ENR CCI** – Since the rate of construction cost inflation varies by geographic region, the ENR CCI converts historic cost information to current dollar values. The ENR CCI for San Francisco (SF) is applied to adjust unit cost and other cost estimates established at a different point in time to a common cost basis. All CoRe Plan estimated construction costs are indexed to an August 2019 ENR CCI SF of 12,368.21.
- **RSMeans Location Factor** – The unit costs presented in RSMeans represent the national average across the United States and Canada. A location factor, also referred to as a city cost index, is applied to account for variations in regional costs such as labor, equipment rental, raw materials, and freight. It represents a weighted average of both materials and labor costs across all divisions of construction. Where national average costs are used from resources such as RSMeans, a location factor of 123.5 percent was applied for the City of San José to account for local cost conditions.

Preliminary design criteria and facility layouts provided the basis for estimating AWPF construction costs. BC collected proposals from equipment manufacturers for treatment process systems such as UF, RO, membrane bioreactor (MBR), and UV. Other resources tapped for AWPF estimates included unit costs from past construction projects and industry estimating resources, such as RSMeans 2019. If cost data were not available, an estimate was made based on engineering judgment and best information available.

3.2 Contractor and Other Markups

Markups are conventionally accepted values and adjusted for the local economy. The following factors apply to facilities estimates:

- **Contingency** – Contingency is incorporated to provide flexibility to address costs related to unforeseen future and circumstances that are possible but cannot be predicted with certainty, such as fluctuations in the economy. Based on industry standard, the level of project definition and complexity, and local factors, construction contingency can range from 10 to 50 percent. This estimate incorporates a 25 percent contingency, selected using engineering judgment.

- **Contractor Overhead and Profit** – Contractor overhead and profit costs consist of standard expenses for a business to remain operational, including staff resources (e.g., salaries, fringe time, benefits), outsourced labor (e.g., accountant, legal, information technology), office costs, tools, equipment/vehicles, training, and insurance. A factor of 15 percent is used based on engineering judgment and past experiences. Overhead and profit is not applied to consumable (e.g., UF/RO replacement membranes or chemicals).
- **Sales Tax** – Sales tax applies to half the subtotal of construction costs and contingency and reflects current local sales rates (as of October 2019).
- **Equipment Installation** – Equipment installation costs consist of relevant labor, equipment delivery, sizing, foundation, and material costs associated with making equipment fully functional. Based on engineering judgment and past experiences, a 50 percent markup on total equipment cost is used as an estimate.

Table 6 presents percentage factors based on raw construction costs and contingency.

Table 6. Contractor and Other Markups

Item	Markup (%)	Applied to
Contingency	25%	Raw construction costs
Contractor's markups		Sum of raw construction costs and contingency
Contractor overhead and profit	15%	
Contractor overhead and Profit – UF/RO/Chemicals Only	0%	
Other markups		
Sales tax on materials (applied to half the construction cost subtotal)	9%	
Equipment installation cost (for AWPFs only)	50%	

3.3 Implementation Costs

Implementation costs are estimated as a percentage of the total construction cost (including contingency, tax, and general contractor overhead and profit). Implementation costs support change orders, engineering design, construction services, and CM. The following factors apply to facilities estimates:

- **Owner's Reserve for Change Orders** – Change orders may be a result of the Owner's direction to implement additional work, differing field conditions that require additional work, or an error in the project contract documents.
- **Engineering Services** – Engineering services include field investigations, such as surveys, geotechnical reports, and hazard materials investigations, preliminary and final design, contract document development, preparation of detailed cost estimations, and project scheduling.
- **Construction Management** – CM includes planning, coordinating, and providing monitoring and controlling of a construction project.
- **Engineering Services During Construction** – Engineering services during construction typically include submittal and request for information reviews, design clarifications, and startup support services.

Table 7 summarizes the implementation cost factors from the *Expedited Purified Water Program Plan* that have been adopted for this estimate. Legal and administration costs are not included as a separate percentage but are accounted for in each of the percentages. Since Valley Water has already retained a consultant for environmental review services, the related cost will not apply to individual project elements. Rather, the cost for environmental review is applied to the overall program cost.

Table 7. Implementation Cost Factors

Element	Percentage [a]
Owner's reserve for change orders	15%
Engineering services (design)	15%
Construction management	13%
Engineering services (construction)	12%

a. Legal and administrative costs for the project are incorporated into the percentage for each element. Environmental review services are not included in the estimate.

Section 4: Operations and Maintenance Costs

Appendix A-6 presents detailed cost estimates, including O&M costs for each portfolio.

4.1 O&M Cost Components

O&M costs are based on estimated labor hours, equipment power and energy needs, chemicals, and other consumable demands. Specific information on unit costs and sources for each element is contained in the unit cost spreadsheet in Exhibit 1 of this document.

4.1.1 Labor

Table 8 summarizes labor unit cost factors based on data received from Valley Water Operations Unit in July 2019. The labor rates are fully loaded and cover base salary, benefits, and employer-paid taxes. Each AWPF facility uses a customized labor estimate based on engineering judgment and individual facility needs.

Table 8. Labor Costs

Plant	Cost	SVAPWC Assumptions
Water plant operator	$163.20/hour	3 operators at the plant; by average each has 1,654 hours/year
Senior mechanics	$172.27/hour	1,460 hours/year
Control tech II	$172.27/hour	1,818 hours/year
Supervisor	$166.58/hour	1,759 hours/year

4.1.2 Electricity

Table 9 summarizes assumptions used for electricity rates at potential facilities.

Table 9. Electric Rates at Potential Facilities

City	Energy Utility	Unit Cost [a]	Basis/Assumptions
Sunnyvale and San José	PG&E	$0.16 per kilowatt hour	Baseline industrial "average" cost, as of July 1, 2019. Rate schedule: E20 Primary Firm
Palo Alto	Palo Alto	$0.19 per kilowatt hour	Average of energy charge for large non-residential electric service summer and winter period effective July 1, 2019. Rate schedule: Utility Rate Schedule E-7

a. *If eligible for PWRPA rates, potential cost savings should be considered in design phase when location and size of improvements are defined.*

4.1.2.1 Chemicals

Table 10 summarizes chemical unit cost estimates.

Table 10. Chemical Costs

Unit Cost	Value	Unit	Source
Liquid oxygen	$0.04	$/lb	Donald C. Tillman Water Reclamation Plant Estimate
Lime	$0.15	$/lb	Donald C. Tillman Water Reclamation Plant Estimate
Sodium hypochlorite	$0.61	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Oxalic acid	$0.71	$/lb	From Yuba City, Alameda County Water District-Union Sanitary District, April 2016
Citric acid	$5.57	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Sodium bisulfite	$2.25	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Sulfuric acid (93%)	$1.00	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Antiscalant (100%)	$20.56	$/gal	SVAWPC (2011)
Sodium hydroxide (50%)	$2.88	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Hydrogen peroxide (H_2O_2)	$5.14	$/gal	Per Trojan O&M analysis, assumes NSF drinking water grade, 50% weight by weight
Aqua ammonium	$0.10	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)
Threshold inhibitor	$19.90	$/gal	Valley Water Operations Unit/O&M info for Existing SVAWPC (August 2019)

4.1.3 Consumables

Assumptions and estimated costs (excluding installation costs) for major consumables related to advanced treatment are summarized in Table 11.

Table 11. Advanced Treatment Major Consumables

Element	Consumable Factor	Value	Source
Granular activated carbon media replacement	Replace every 2 years	$61 per cubic foot	Engineering judgement
UV lamp replacement	Replace every 12,000 hours of usage	$195.97 per unit	Valley Water Operations Unit
UV ballast replacement	Replace every 5 years	$794.03 per unit	Valley Water Operations Unit
Membrane replacement – UF	Replace every 3 years	$1,980.26 per unit	Vendor quote
Membrane replacement – MBR	Replace every 3 years	$1,980.26 per unit	Engineering judgment
Membrane replacement – RO	Replace every 5 years	$347.13 per unit	Valley Water Operations Unit
Pumping equipment consumables	--	2% of pumping equipment	Engineering judgment
Electrical consumables	--	2% of electrical costs	Engineering judgment
Instrumentation consumables	--	2% of instrumentation and controls	Engineering judgment

4.2 AWPF

AWPF O&M consists of labor, electricity, chemicals, and consumables.

- **Labor** – The annual labor requirements for the AWPF depend on the capacity of the facility, the equipment, and the hours of operation. Each AWPF has a separate staffing plan. AWPF cost estimates include labor required for pump station O&M, such as exercising valves, managing run times for pumps, and examining performance (flow and pressure) data. Routine maintenance may include inspecting equipment, exercising valves, and servicing instrumentation. Labor cost estimates are based on SVAWPC costs and engineering judgment.
- **Energy** – Horsepower sizing for motorized equipment was either provided by vendors or estimated based on facility hydraulics. Electricity estimates for equipment, such as pumps and blowers, are based on equipment horsepower and run times. Electricity rates vary depending on facility location. See Table 9 for electricity rates for each site.
- **Chemicals** – Chemical costs for each AWPF are estimated based on dosing amounts provided in the design criteria. Chemical concentration was initially established for 24-mgd facilities and then scaled based on flow.
- **Consumables** – Consumables are estimated based on design criteria and equipment proposals for each AWPF. Costs are project- and site-specific and depend on equipment and electricity rates.

4.3 Pipeline

Pipeline O&M consists of labor.

- **Labor** – Pipelines require regularly scheduled maintenance that may include the exercising valves, inspecting appurtenances, and flushing procedures at dead ends. Cost estimates reflect assumed requirement of 1.0 operator hour per year to maintain 100 feet of pipe.

Pipelines require a minimal amount of operational labor resources, as most of the operations occur at the pump station or at the discharge point (i.e., injection well or recharge pond). Therefore, it is assumed that there are no operational labor requirements for pipelines.

4.4 Pump Station

Pump station O&M consists of labor, power, and consumables.

- **Labor** – Pump station O&M labor costs are reflected in the estimates for AWPF labor.
- **Energy** – Pump station electricity consumption is estimated by evaluating the total flow, total dynamic head, and an assumed 80 percent pump efficiency.
- **Consumables** – Pump station consumables are valued at 2 percent each of the total equipment, mechanical, electrical, and instrumentation costs associated with the pump station.

4.5 Recharge Ponds

Los Gatos Recharge Ponds O&M consists of labor.

- **Labor** – Routine maintenance and cleaning of the percolation ponds is essential to maintaining the ponds' recharge capabilities. Pond maintenance includes the removing sediments, vegetation, and other materials that may limit the ponds' performance, and ripping the soils to improve percolation. Labor costs are escalated from the Expedited Purified Water Program Plan using August 2017 values.

4.6 NPR Distribution System

NPR distribution systems do not have separately identified O&M costs. For example, it is assumed that South Bay Water Recycling's (SBWR) NPR+ distribution system expansion would be covered by existing SBWR staff and funding.

Section 5: Replacement and Renewal Costs

Assets must be maintained over their life cycles to continue to operate as intended. Assets will require major replacement and renewal over time as elements age beyond their useful lives. The age at which a particular element requires major replacement and renewal varies based on a number of factors, including service conditions, process duty, environmental conditions, materials and quality of construction, and adherence to recommended maintenance procedures. Valley Water has a robust asset management program and evaluates R&R costs as part of the life-cycle cost analysis. BC developed the approach for estimated costs to align with Valley Water's standards and expectations for useful lives of assets.

R&R frequency cycles refer to estimates of how many years it will take for an asset to require replacement or renewal/refurbishment. Cycles used for the life-cycle cost assessment are from three main sources, presented in order of priority reference:

- **Valley Water R&R Frequency Schedule** – Values are from Valley Water's Management Strategy.V.65 worksheet, provided July 2019. The worksheet contains an export of the agency's asset database, including replacement and renewal frequencies for existing specific assets. If equipment specified in CoRe Plan cost estimates matched assets in the database, these R&R values were used. Exhibit 2 presents the R&R values from the Valley Water asset database that were used to create the life-cycle evaluation.
- **Expedited Purified Water Program Assumptions** – Values are from the Expedited Purified Water Program Plan's basis of cost memorandum. If a given asset did not have values in Valley Water's asset database, these values were used.
- **Standard industry sources** – Values are from BC's database of standard industry and agency sources. If a given asset did not have values in Expedited Purified Water Program Plan's basis of cost memorandum, these values were used.

Replacement costs are 100 percent of the original capital cost for the asset. In the case of packaged estimates, such as for the RO system and all its components, engineers determined the proportion of the original cost to apply to replacement cycles. Renewal costs are a percentage of the original capital cost for the asset. Where no renewal cycle is shown, only a replacement lifecycle is assumed, in addition to annualized operations and maintenance costs. Consumables, such as UV lamp and ballast replacements, are not factored into the R&R cycles.

Table 12 provides the expected duration cycles for R&R by asset class and the percentage of original capital cost used to calculate the renewal cost.

Table 12. Replacement and Renewal Cycles by Asset Class				
		Replacement	Renewal	
Asset Class	Basis of Recommendation	Cycle (years)	Cycle (years)	Costs (percent)
Above and below grade concrete (slabs, pads, vaults, etc.)	Expedited Purified Water Program	100	25	25%
Biologically activated carbon (BAC) system	Engineer's Estimate	50	25	75%
Canopies, steel	Expedited Purified Water Program	75	0	0%
Concrete water tank	DN Tanks vendor proposal	100	20	1%
Decarbonator system	Expedited Purified Water Program	40	20	20%
Electrical Equipment and Accessories	Valley Water asset database	25	0	0%
Flow Meters	Valley Water asset database	10	0	0%
Instrumentation (except flow meters)	Expedited Purified Water Program	20	0	0%
Lime System	Engineer's Estimate	50	25	75%
MBR System	Engineer's Estimate	50	25	75%
Metals and Fencing	Valley Water asset database	75	0	0%
NO CAPITAL/R&R COST		0	0	0%
Ozone system	Engineer's Estimate	50	25	75%
Piping, Conveyance	Expedited Purified Water Program	100	20	4%
Piping, Process (stainless steel or equivalent)	Replacement - Expedited Purified Water Program; Renewal - Standard industry sources	100	0	0%
Process Building (prefabricated steel, single story)	Valley Water asset database	75	0	0%
Pumps, Chemical metering	Valley Water asset database	10	0	0%
Pumps, Process/Product, >200 HP	Valley Water asset database	50	25	30%
Pumps, Process/Product, 100-200 HP	Valley Water asset database	30	15	30%
Pumps, Process/Product, 25-50 HP submersible	Valley Water asset database	15	0	0%
Pumps, Process/Product, 25-75 HP	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program	20	10	30%
RO System	Engineer's Estimate	50	25	75%
Roadways and Walkways	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program	75	30	25%
Static Mixers	Valley Water asset database	40	0	0%
Subgrade Structural Piles	Expedited Purified Water Program	70	30	25%
Tanks, Chemical (carbon steel, vertical)	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program	40	8	20%
Tanks, Chemical (fiberglass reinforced plastic, vertical)	Expedited Purified Water Program	25	8	20%
Tanks, Chemical (high-density polyethylene, vertical)	Expedited Purified Water Program	25	8	20%
Tanks, Process (steel)	Expedited Purified Water Program	50	20	30%
UF system	Engineer's Estimate	50	25	75%
UV System	Engineer's Estimate	50	25	75%
Valves	Expedited Purified Water Program	30	0	0%

Section 6: Water Supply Costs

Water supply source costs assume excess flow is available throughout the year, though long-term production is limited due to hydrologic constraints. Long-term production is modeled at 18,500 AFY,[1] except for the Morgan Hill facility (which assumes 2.5 mgd is available for satellite treatment, at no cost). The estimate assumes a standard water supply purchase cost of $100/AF, based on the in-development agreement between Valley Water and Palo Alto ($1 million/year for 9 mgd). Tables 13 and 14 provide source flow assumptions and annual flow by portfolio, respectively. In the case of Morgan Hill Option 1, the supply cost of $600/AF is assumed based on a rounded "cost recovery rate" provided by city of San Jose staff during a meeting on March 20, 2020.

Table 13. Source Flow Assumptions

Item	Assumed Value
MF recovery rate	93%
RO recovery rate	85%
Purchase cost [a]	$100/AF

a. *Source water costs may be revisited pending agreements with Partner Agencies.*

Table 14. Annual Source Flow by Portfolio

Portfolio	AWPF description	Long-term Production Capacity (AFY)	Max. Annual Source Flow (AFY)
1a	24-mgd plant in San José; full advanced treatment (FAT) process	18,500	23,400
1b	24-mgd plant in San José; FAT process plus ozone-biological activated carbon (BAC)	18,500	23,400
1c & 1d	24-mgd plant in San José; FAT process plus ozone-BAC and chlorine disinfection	18,500	23,400
2a	24.5-mgd plant in Palo Alto (0.5 for NPR+); FAT process	18,500	23,400
2b	24.5-mgd plant in Sunnyvale (0.5 for NPR+); FAT process	18,500	23,400
4	14-mgd plant in Palo Alto; FAT process	10,800	13,700
	10.5-mgd plant in Sunnyvale (0.5 for NPR+); FAT process	7,700	9,700
Westside TWA	24-mgd plant in Palo Alto; FAT process plus ozone-BAC and chlorine disinfection	18,500	23,400

Appendix A-6 presents detailed cost estimates, including water supply costs for each portfolio. For the life-cycle cost assessment, water supply is included as part of the O&M costs.

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[1] Based on Valley Water's Water Evaluation and Planning System (WEAP) modeling performed for the Expedited Purified Water Program Plan.

Section 7: Life-cycle Cost Evaluation

The cost estimates provided in detail in Appendix A-6 form the basis of the life-cycle cost assessment. A life-cycle evaluation captures the full estimated capital cost to construct and implement, operate, and maintain a facility over a set period, and it accounts for both inflation and discounting. For the CoRe Plan, Valley Water uses a 30-year and 100-year life-cycle cost evaluation to compare and evaluate water supply alternatives.

The life-cycle evaluation evaluates the total cost and dollars per AF of each portfolio over a 30-year and 100-year life-cycle span. The life-cycle evaluation consists of capital; R&R of major equipment; and O&M costs of new treatment facilities, pump stations, pipelines, and water supplies. The life-cycle assessment does not incorporate reverse osmosis concentrate (ROC) management, interties, or NPR distribution costs with the exception of Morgan Hill Option 1, which did include NPR+ distribution costs.

The life-cycle evaluation calculates present value costs. Present value costs convert future payments—e.g., costs that will need to be paid in 10 or 50 years—to today's dollars. It takes into consideration a fundamental principle of business finance: the time value of money, in which one dollar today has greater value than one dollar in the future. The time value of money is affected by inflation, which decreases purchasing power, and opportunity cost (such as foregoing money that could have been invested to gain more money). This life-cycle analysis evaluates future potential spend over a fixed period while controlling for inflation and for the discount rate, which adjusts future cash flows to the present day.

Table 15 summarizes the life-cycle factors and assumptions affecting the life-cycle cost assessment.

Table 15. Life-cycle Factors and Assumptions

Element	Notes
Discount rate	Valley Water uses a discount rate of 5.5%.
Inflation rate	Valley Water uses a cost escalation (inflation) rate of 3.0%.
Real discount rate	Valley Water applies a real discount rate of 2.43% based on a 5.5% discount rate and 3% inflation rate. The real discount rate was applied to the projected expenditures to identify the 2019 present value of projected expenditures. The real discount rate formula is ((1+discount rate)/(1+inflation rate))-1.
Base year	The base year for nominal dollars is 2019.
Salvage value	Remaining salvage value at the end of the 100-year period is not considered in the life-cycle evaluation.
Implementation and construction period	Capital expenditure associated with design, implementation, and construction are anticipated to begin in 2024 for most facilities and end in 2027.
Operational period	Facilities are projected to start operation in 2028 and operate for 100 years to 2127.

Consistent with Valley Water's unit life-cycle methodology, the annual water supply yields are discounted at the real discount rate (2.43%), based on a 5.5% discount rate and 3% inflation rate. The real discount rate was applied to the projected expenditures to estimate the total "present value yield" for a supply alternative. Remaining salvage value at the end of the 100-year period is not considered in the life-cycle evaluation. The total present value cost is then divided by the total present value yield of that component to determine the life-cycle unit cost ($/AF).

Table 16 provides key references for the economic comparison of life cycles.

Table 16. References for Economic Comparison of Life Cycles

Term	Description
Estimated capital	Estimated nominal (without applying inflation or discount rates) capital costs for the entire life cycle; represented in August 2019 dollars
Estimated O&M	Estimated nominal (without applying inflation or discount rates) O&M costs for the entire life cycle; represented in August 2019 dollars Water supply source costs ($2.5M/year per portfolio) are included in this estimate. (Source water costs may be revisited pending agreements with Partner Agencies.)
Estimated R&R	Estimated nominal (without applying inflation or discount rates) costs for R&R of major equipment, represented in August 2019 dollars
Total cost	Sum of estimated nominal (without applying inflation or discount rates) capital, O&M, and R&R costs, represented in August 2019 dollars
Total cost, present value	Current value of estimated capital, O&M, and R&R costs that will be incurred over the project lifespan. Present value costs reflect Valley Water's real discount rate (2.43%; costs inflated at 3% and then discounted back to current dollars at 5.5%), represented in 2019 dollars Assumes construction begins in 2024 and operations begin in 2028
Annual yield	Average water supply system yield, represented in AF Assumes yield per portfolio is 18,500 AFY
Present value yield	Per Valley Water's unit life-cycle approach, annual water supply system yields are discounted at the real discount rate (2.43%), represented in AF
Life-cycle unit cost	Present value cost divided by the present value yield, represented in $/AF

The format for the life-cycle cost summary contains fields for estimated nominal costs and present value costs (represented in 2019 dollars), water supply system yields (represented in AF), and life-cycle unit costs (represented in $/AF) for the 30-year and 100-year life cycles for each portfolio. Section 5 of the Feasible Project Portfolios summarizes the life-cycle costs for each portfolio.

Actual results of the life-cycle evaluation for each portfolio are in Appendix A-6.

Exhibit 1: AWPF Unit Costs

This exhibit provides a list of AWPF capital and O&M unit costs.

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Brown AND Caldwell

Unit Costs (Construction and O&M)

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
O&M	Labor		Water Plant Operator	$/hr	$ 163.20	1.00	$ 163.20	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Sr Mechanics	$/hr	$ 172.27	1.00	$ 172.27	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Control Tech II	$/hr	$ 172.27	1.00	$ 172.27	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Labor		Supervisor	$/hr	$ 166.58	1.00	$ 166.58	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Power		Electricity - San Jose	$/kWh	$ 0.10	1.00	$ 0.10	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		SVAWPC Rate
O&M	Power		Electricity - Sunnyvale	$/kWh	$ 0.16	1.00	$ 0.16	PG&E		
O&M	Power		Electricity - Palo Alto	$/kWh	$ 0.19	1.00	$ 0.19	Palo Alto Utility		
O&M	Chemicals		Calcium Chloride	$/gal	$ 0.53	1.03	$ 0.54	City of Los Angeles Groundwater Replenishment Master Planning Report, Appendix B, Table B-2		
O&M	Chemicals		Sodium Hypochlorite	$/gal	$ 0.61	1.00	$ 0.61	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Citric Acid	$/gal	$ 5.57	1.00	$ 5.57	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Sodium Bisulfite	$/gal	$ 2.25	1.00	$ 2.25	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		based on $618.64 per tote
O&M	Chemicals		Sulfuric Acid (93%)	$/gal	$ 1.00	1.00	$ 1.00	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		based on $139.87 per ton
O&M	Chemicals		Antiscalant (100%)	$/gal	$ 16.82	1.22	$ 20.56	SVAWPC (2011)		SVAWPC Chemical Cost.msg (confidential folder); based on $1.92/lb
O&M	Chemicals		Sodium Hydroxide (50%)	$/gal	$ 2.88	1.00	$ 2.88	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Hydrogen Peroxide (H2O2)	$/gal	$ 5.00	1.03	$ 5.14	Per Trojan O&M analysis		assumes NSF drinking water grade, 50% w/w
O&M	Chemicals		Aqueous Ammonium	$/gal	$ 0.10	1.00	$ 0.10	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Chemicals		Threshold Inhibitor	$/gal	$ 19.90	1.00	$ 19.90	Valley Water Operations Unit / O&M info for Existing SVAWPC (August 2019)		
O&M	Consumables		MF Membrane Module Replacement	$/unit	$ 1,850	1.07	$ 1,980.26	From Yuba City ACWD-USD (April 2016)		vendor quote
O&M	Consumables		RO Module Replacement	$/unit	$ 347	1.00	$ 347.13	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote
O&M	Consumables		UV Lamp Replacement	$/unit	$ 196	1.00	$ 195.97	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote
O&M	Consumables		UV Ballast Replacement	$/unit	$ 794	1.00	$ 794.03	Valley Water Operations Unit / O&M info for Existing SVAWPC, August 2019 - SVAWPC Rate		vendor quote

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
O&M	Consumables		Decarbonator Media	$/cubic foot	$ 52	1.07	$ 55.66	vendor quote		8/23/2016, Westech forced draft
Division 40 – Process Integration	Conduit		PVC Conduit 2"	$/LF	$ 7.35	1.32	$ 9.67	RS Means (2017)	*26.05.39.30.3350*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		PVC Conduit, 1" Dia.	$/LF	$ 4.23	1.32	$ 5.57	RS Means (2017)	*26.05.39.30.3270*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		PVC Conduit, 0.75" Dia	$/LF	$ 3.57	1.32	$ 4.70	RS Means (2017)	*26.05.39.30.3250*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		#14 Wire, 2 conductor	$/LF	$ 1.97	1.32	$ 2.59	RS Means (2017)	*26.05.19.55.1450*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#12 Wire, 2 Conductor	$/LF	$ 2.35	1.32	$ 3.09	RS Means (2017)	*26.05.19.55.1500*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#10 Wire, 2 Conductor	$/LF	$ 2.90	1.32	$ 3.82	RS Means (2017)	*26.05.19.55.1550*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#14 Wire, 3 conductor	$/LF	$ 2.33	1.32	$ 3.07	RS Means (2017)	*26.05.19.55.1600*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#12 Wire, 3 Conductor	$/LF	$ 2.85	1.32	$ 3.75	RS Means (2017)	*26.05.19.55.1650*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		#10 Wire, 3 Conductor	$/LF	$ 3.65	1.32	$ 4.80	RS Means (2017)	*26.05.19.55.1700*	UF underground feeder cable, copper with ground
Division 40 – Process Integration	Conduit		Rigid Steel Conduit 2"	$/LF	$ 17.50	1.32	$ 23.03	RS Means (2017)	*26.05.39.30.4800*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Rigid Steel Conduit, 1" Dia.	$/LF	$ 12.55	1.32	$ 16.51	RS Means (2017)	*26.05.39.30.4450*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Rigid Steel Conduit, 0.75" Dia.	$/LF	$ 8.75	1.32	$ 11.51	RS Means (2017)	*26.05.39.30.4400*	Conduit in concrete slab, including terminations, fittings, and supports
Division 40 – Process Integration	Conduit		Junction Box (6"x6"x6")	$/EA	$ 87	1.32	$ 113.81	RS Means (2017)	*26.05.33.18.2150*	NEMA 3R, type SC, raintight and weatherproof
Division 11 – Equipment	Conduit		Precast Electrical Handhole (3'x3'x3')	$/EA	$ 1,600	1.32	$ 2,105.15	RS Means (2017)	*33.71.19.17.0800*	
Division 11 – Equipment	Rental		Backhoe Rental	$/month	$ 5,825	1.32	$ 7,664.05	RS Means (2017)	*01.54.33.20.0470*	112hp, 1-1/2 CY capacity
Division 11 – Equipment	Rental		Backhoe Rental	$/week	$ 1,945	1.32	$ 2,559.07	RS Means (2017)	*01.54.33.20.0470*	112hp, 1-1/2 CY capacity
Division 11 – Equipment	Rental		Forklift	$/month	$ 4,675	1.32	$ 6,150.98	RS Means (2017)	*01.54.33.40.2050*	rough terrain, 42' lift, 35' reach, 9000lb, 110hp
Division 11 – Equipment	Rental		Forklift	$/week	$ 1,555	1.32	$ 2,045.94	RS Means (2017)	*01.54.33.40.2050*	rough terrain, 42' lift, 35' reach, 9000lb, 110hp
Division 11 – Equipment	Rental		Crane	$/month	$ 4,725	1.32	$ 6,216.76	RS Means (2017)	*01.54.33.60.3050*	self-propelled, 4x4, w/ telescoping boom, 20 ton
Division 11 – Equipment	Rental		Crane	$/week	$ 1,575	1.32	$ 2,072.25	RS Means (2017)	*01.54.33.60.3050*	self-propelled, 4x4, w/ telescoping boom, 20 ton
Division 11 – Equipment	Rental		Barge	$/month	$ 9,800	1.32	$ 12,894.03	RS Means (2017)	*01.54.33.80.0200*	400 ton, 30' x 90'
Division 11 – Equipment	Rental		Barge	$/week	$ 3,265	1.32	$ 4,295.82	RS Means (2017)	*01.54.33.80.0200*	400 ton, 30' x 90'
Division 31 – Earthwork			Trench Excavation Cost (6' - 10' deep)	$/CY	$ 4.95	1.00	$ 4.95	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.0510*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Trench Excavation Cost (10' - 14' deep)	$/CY	$ 5.50	1.00	$ 5.50	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.0910*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Trench Excavation Cost (14' - 20' deep)	$/CY	$ 6.18	1.00	$ 6.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.1300*	common earth with not sheeting or dewatering included, 1 CY excavator
Division 31 – Earthwork			Shoring, Sheet Piling Steel, 15'	$/SF	$ 24.61	1.00	$ 24.61	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.1300*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Shoring, Sheet Piling Steel, 25'	$/SF	$ 30.41	1.00	$ 30.41	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.1900*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Shoring, Wood Sheeting, 8'	$/SF	$ 12.18	1.00	$ 12.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.41.16.10.3910*	sheeting excavation (drive, extract, salvage)
Division 31 – Earthwork			Clear and Grub Site	$/Acre	$ 7,760.00	1.00	$ 7,760.00	RS Means (2019) - raw unit costs have location factor embedded in it	*31.11.10.10.0020*	
Division 31 – Earthwork			Strip Topsoil	$/SY	$ 0.85	1.00	$ 0.85	RS Means (2019) - raw unit costs have location factor embedded in it	*31.14.13.23/155-*	For areas 1101-4000 SY by dozer

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 31 – Earthwork			Structure Excavation	$/CY	$ 11.78	1.00	$ 11.78	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.16.6060*	machine excavation, for spread and mat footings, elevator pits, small building foundations, 2 CY bucket
Division 31 – Earthwork			Sheepsfoot Compaction	$/CY	$ 0.89	1.00	$ 0.89	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.23.5720*	12" lifts, 4 passes
Division 31 – Earthwork			Site Grading (small, irregular areas)	$/SY	$ 2.97	1.00	$ 2.97	RS Means (2019) - raw unit costs have location factor embedded in it	*31.22.16.10.1050*	small, irregular areas
Division 31 – Earthwork			Site Grading (for large parking lots)	$/SY	$ 1.18	1.00	$ 1.18	RS Means (2019) - raw unit costs have location factor embedded in it	*31.22.16.10.1020*	large parking lots
Division 31 – Earthwork			Backfilling (trench)	$/CY	$ 12.44	1.00	$ 12.44	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.16.13.3060*	1 CY bucket, 200'
Division 31 – Earthwork			Backfill (structural)	$/CY	$ 1.04	1.00	$ 1.04	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.14.4020*	200 HP, 50' haul, common earth from stockpile
Division 31 – Earthwork			Material haul	$/CY	$ 8.88	1.00	$ 8.88	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.20.4112*	20 CY truck, 15 min wait, 50 MPH, cycle 40 miles (approx distance from San Martin to SVAWPC)
Division 31 – Earthwork			Aggregate Base	$/CY	$ 49.61	1.00	$ 49.61	RS Means (2019) - raw unit costs have location factor embedded in it	*31.23.23.16.0050*	crushed or screened bank run gravel
Division 31 – Earthwork			Aggregate Base with Material Hauling	$/CY	$ 58.49	1.00	$ 58.49	*See Above*		crushed or screened bank run gravel; 20 CY truck, 15 min wait, 50 MPH, cycle 40 miles (approx distance from San Martin to SVAWPC)
Division 31 – Earthwork			Base Course Drainage (Gravel)	$/SY	$ 4.63	1.00	$ 4.63	RS Means (2019) - raw unit costs have location factor embedded in it	*32.11.23.23.0050*	crushed 3/4" stone base, compacted, 3" deep
Division 31 – Earthwork			Subgrade Structural Piles Fabrication and delivery	$/SF	$ 68.38	1.22	$ 83.60	SVAWPC (2011)		14'x14' prestressed concrete piles, fabrication/ delivery- SVAWPC interprocess and product water storage tanks
Division 31 – Earthwork			Subgrade Structural Piles	$/SF	$ 47.12	1.22	$ 57.60	SVAWPC (2011)		14'x14' prestressed concrete piles including installation, SVAWPC interprocess tank -5ft spacing between piles
Division 31 – Earthwork			Subgrade Structural Piles	$/SF	$ 5.29	1.22	$ 6.47	SVAWPC (2011)		14'x14' prestressed concrete piles including installation, SVAWPC product water tank -5 ft 10in between piles
Division 31 – Earthwork			Flowable Fill - 40-80 psi	$/CY	$ 88.50	1.32	$ 116.44	RS Means (2017)	*03.31.13.35.4100*	Ash, cement aggregate, water / (identical to CLSM)
Division 31 – Earthwork			Flowable fill Structural - 50 psi	$/CY	$ 88.50	1.32	$ 116.44	RS Means (2017)	*03.31.13.35.4200*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 140 psi	$/CY	$ 89.50	1.32	$ 117.76	RS Means (2017)	*03.31.13.35.4250*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 500 psi	$/CY	$ 92.50	1.32	$ 121.70	RS Means (2017)	*03.31.13.35.4300*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Flowable fill Structural - 1000 psi	$/CY	$ 96.00	1.32	$ 126.31	RS Means (2017)	*03.31.13.35.4350*	Ash, cement, aggregate, water and sand
Division 31 – Earthwork			Bituminous concrete, 4" thick [asphalt]	$/SF	$ 2.01	1.00	$ 2.01	RS Means (2019) - raw unit costs have location factor embedded in it	32.11.26.13.0500	Plant mix asphaltic base courses for roadways and large paved areas
Division 31 – Earthwork			Sawcut 4" Pavement	$/LF	$ 3.70	1.00	$ 3.70	RS Means (2019) - raw unit costs have location factor embedded in it		From Pleasanton estimate
Division 31 – Earthwork			Dewatering	$/CY	$ 17.16	1.00	$ 17.16	RS Means (2019) - raw unit costs have location factor embedded in it	31.23.19.20 0020	
Division 31 – Earthwork			Rotary Lobe Blower, 5.5 bhp	$/EA	$ 4,800	1.32	$ 6,315.44	RS Means (2017)	46.51.20.10.0430	125 cfm, includes 3 phase motor, filter, silencer, valves, check valve, pressure gage
Division 31 – Earthwork			Sump pumps, 1/2HP, 1-1/4" discharge	$/EA	$ 480	1.32	$ 631.54	RS Means (2017)	22.14.29.16.7560	cast iron, submersible
Division 31 – Earthwork			Sump pumps, 30HP, 6" discharge	$/EA	$ 10,200	1.32	$ 13,420.31	RS Means (2017)	22.14.29.13.2090	wet-pit-mounted, vertical sump pumps, 1000 GPM
Division 46 – Water and Wastewater Equipment			Automatic Strainer	$/EA	$ 13,750	1.22	$ 16,810.80	SVAWPC (2011)		SCAWPC cost; $/EA estimated per (4) automatic strainers

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 46 – Water and Wastewater Equipment			Static Mixer	$/EA	$ 9,700	1.25	$ 12,132.39	Based on quote for NSD Contract D for static mixer (September 2010)		0.2 mgd, min flow; 1.5 mgd, normal flow; 5.1 max flow; pressure drop across max flow - 5.4 psig
Division 46 – Water and Wastewater Equipment	Steel Tanks		250,000 gal steel water storage tank	$/EA	$ 443,250	1.00	$ 443,250.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1000	Not including foundation; adding installation factor
Division 46 – Water and Wastewater Equipment	Steel Tanks		375,000 gal steel water storage tank	$/EA	$ 534,375	1.00	$ 534,375.00	RS Means (2019) - raw unit costs have location factor embedded in it		Interpolated
Division 46 – Water and Wastewater Equipment	Steel Tanks		500,000 gal steel water storage tank	$/EA	$ 625,500	1.00	$ 625,500.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1200	Not including foundation; adding installation factor
Division 46 – Water and Wastewater Equipment	Steel Tanks		750,000 gal steel water storage tank	$/EA	$ 807,000	1.00	$ 807,000.00	RS Means (2019) - raw unit costs have location factor embedded in it	33.16.13.13 1250	Not including foundation; adding installation factor
Division 08 – Doors and Windows	Building Specialties		Doors and Hardware	$/LS	$ 35,000	1.22	$ 42,791.12	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Overhead Doors	$/LS	$ 50,000	1.22	$ 61,130.17	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Windows	$/LS	$ 50,000	1.22	$ 61,130.17	SVAWPC (2011)		SVAWPC cost; assumed LS
Division 08 – Doors and Windows	Building Specialties		Showers and Lockers	$/LS	$ 17,400	1.22	$ 21,273.30	SVAWPC (2011)		SVAWPC installed cost; assumed 50% installation to get material cost
Division 08 – Doors and Windows	Building Specialties		Sinks and Toilets	$/LS	$ 12,000	1.22	$ 14,671.24	SVAWPC (2011)		SVAWPC installed cost; assumed 50% installation to get material cost
Division 08 – Doors and Windows	Building Specialties		Bollards, 6" diameter	$/EA	$ 770	1.32	$ 1,013.10	RS Means (2017)	32.17.13.13.1300	concrete filled/paint, 8' L x 4' D hole, 6" diameter
Division 08 – Doors and Windows	Building Specialties		Pre-Fab Steel Bldg	$/SF	$ 25.00	1.32	$ 32.89	RS Means (2017)	13.34.19.50.0400	30' to 49' wide, 16' eave height
Division 08 – Doors and Windows	Building Specialties		Single Leaf Door	$/EA	$ 1,175	1.32	$ 1,545.97	RS Means (2017)	13.34.19.50.5825	
Division 08 – Doors and Windows	Building Specialties		Double Leaf Door	$/EA	$ 2,275	1.32	$ 2,993.26	RS Means (2017)	13.34.19.50.6000	
Division 08 – Doors and Windows	Building Specialties		Eave Overhang	$/LF	$ 54.50	1.32	$ 71.71	RS Means (2017)	13.34.19.50.5250	2' wide, 26 ga., with soffit
Division 08 – Doors and Windows	Building Specialties		Flashings	$/LF	$ 11.20	1.32	$ 14.74	RS Means (2017)	13.34.19.50.6250	26 ga., corner, or eave, painted
Division 08 – Doors and Windows	Building Specialties		Gutters	$/LF	$ 12.60	1.32	$ 16.58	RS Means (2017)	13.34.19.50.6550	gutter, eave type, 26 ga. Painted
Division 08 – Doors and Windows	Building Specialties		Insulation	$/SF	$ 1.83	1.32	$ 2.41	RS Means (2017)	13.34.19.50.6730	10" thick, R30
Division 08 – Doors and Windows	Building Specialties		Windows	$/EA	$ 1,100	1.32	$ 1,447.29	RS Means (2017)	13.34.19.50.7800	sash, single slide, glazed, with screens 6040 (6'x4')
Division 08 – Doors and Windows	Building Specialties		Skylight	$/EA	$ 365	1.32	$ 480.24	RS Means (2017)	13.34.19.50.8200	fiberglass panels, to 30 SF
Division 08 – Doors and Windows	Building Specialties		Stairs	$/RISER	$ 525	1.32	$ 690.75	RS Means (2017)	05.51.19.50.0020	grating stairs, grating tread and pipe railing, 3.5' wide
Division 08 – Doors and Windows	Building Specialties		Handrails	$/LF	$ 63	1.32	$ 82.23	RS Means (2017)	05.52.13.50.0560	steel, 2 rail, on stairs, galvanized, 1-1/2" diameter
Division 08 – Doors and Windows	Building Specialties		Landing	$/SF	$ 107	1.32	$ 140.78	RS Means (2017)	05.51.13.50.1500	
Division 08 – Doors and Windows	Building Specialties		Eyewash/Shower	$/EA	$ 5,000	1.32	$ 6,578.59	grainger		HAWS stainless steel, installed; January 2016 number (based on previous estimates)
Division 08 – Doors and Windows	Building Specialties		Precast Polymer Trench Drain	$/LF	$ 61.50	1.32	$ 80.92	RS Means (2017)	22.14.26.19.6680	not including trenching, heavy duty iron grate
Division 08 – Doors and Windows	Building Specialties		Precast Beam - 30' Span 24"x36"	$/LF	$ 291	1.32	$ 382.61	RS Means (2017)	B1010.213.7100	
Division 13 – Special Construction	Building Material		Prefabricated Building	$/SF	$ 179	1.22	$ 218.58	SVAWPC (2011)	RSMeans lists $14.70 for non-furnished building cost (13.34.19.50.4200)	installed cost; SCAWPC cost; $/SF estimated with area of process building, 135'x235'
Division 13 – Special Construction	Building Material		Canopy	$/SF	$ 74	1.22	$ 90.93	SVAWPC (2011)		installed cost; SVAWPC cost; $/SF estimated with area of chemical storage canopy at 10'x26'
Division 32 – Exterior Improvements	Building Material		Chain Link Fence	$/LF	$ 53	1.00	$ 52.94	RS Means (2019) - raw unit costs have location factor embedded in it	*32.31.13.20.0940*	Aluminized steel, 6 ga., Wire, 2" posts @ 10' OC, 6' high, includes excavation and concrete
Division 03 – Concrete	Concrete		Glazed Concrete Block	$/SF	$ 44.92	1.00	$ 44.92	RS Means (2019) - raw unit costs have location factor embedded in it	04.22.10.44.0800	double face, 8" x 16" units, 8" thick
Division 03 – Concrete	Concrete		Retaining Wall	$/CY	$ 513.21	1.00	$ 513.21	RS Means (2019) - raw unit costs have location factor embedded in it	03.30.53.40.6200	gravity, 4' high (more expensive than 10' high wall and is the same as 8' cantilever wall)

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 03 – Concrete	Concrete		Concrete - Slab on grade	$/CY	$ 645.00	1.00	$ 645.00	Created Sage Assy. (via Des)		Assume 14" thick slab, thickened edge, fine grading incl, 6" base, edge forms, 140#/cy rebar, 10' x 20' slab, CJs, waterstops
Division 03 – Concrete	Concrete		Concrete - 10" Elevated Slab	$/CY	$ 1,150.00	1.00	$ 1,150.00	Created Sage Assy. (via Des)		
Division 03 – Concrete	Concrete		Concrete - 14" Walls	$/CY	$ 1,090.00	1.00	$ 1,090.00	Created Sage Assy. (via Des)		
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		4"	$/EA	$ 1,225	1.32	$ 1,611.75	RS Means (2017)	33.12.16.10.3810	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		6"	$/EA	$ 1,725	1.32	$ 2,269.61	RS Means (2017)	33.12.16.10.3814	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		8"	$/EA	$ 2,725	1.32	$ 3,585.33	RS Means (2017)	33.12.16.10.3816	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		10"	$/EA	$ 4,500	1.32	$ 5,920.73	estimate		
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		12"	$/EA	$ 6,200	1.32	$ 8,157.45	RS Means (2017)	33.12.16.10.3820	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		16"	$/EA	$ 18,800	1.32	$ 24,735.48	RS Means (2017)	33.12.16.10.3824	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		20"	$/EA	$ 31,200	1.32	$ 41,050.38	RS Means (2017)	33.12.16.10.3828	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		24"	$/EA	$ 45,900	1.32	$ 60,391.42	RS Means (2017)	33.12.16.10.3830	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		30"	$/EA	$ 43,300	1.32	$ 56,970.55	RS Means (2017)	33.12.16.10.3831	
Division 33 – Utilities	Gate Valves (cast iron), 125 PSI, mechanical joint, with boxes		36"	$/EA	$ 69,000	1.32	$ 90,784.48	RS Means (2017)	33.12.16.10.3832	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		4"	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	33.12.16.10.3100	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		8"	$/EA	$ 1,275	1.32	$ 1,677.54	RS Means (2017)	33.12.16.10.3180	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		12"	$/EA	$ 2,050	1.32	$ 2,697.22	RS Means (2017)	33.12.16.10.3340	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		14"	$/EA	$ 4,050	1.32	$ 5,328.65	RS Means (2017)	33.12.16.10.3400	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		18"	$/EA	$ 6,700	1.32	$ 8,815.30	RS Means (2017)	33.12.16.10.3460	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		20"	$/EA	$ 8,650	1.32	$ 11,380.95	RS Means (2017)	33.12.16.10.3480	
Division 33 – Utilities	Butterfly Valves (cast iron), mechanical joint, with boxes		24"	$/EA	$ 14,100	1.32	$ 18,551.61	RS Means (2017)	33.12.16.10.3500	
Division 33 – Utilities	Air Release Valve for Water		1/2" inlet	$/EA	$ 132	1.32	$ 173.67	RS Means (2017)	33.12.16.20.1000	
Division 33 – Utilities	Air Release Valve for Water		3/4" inlet	$/EA	$ 132	1.32	$ 173.67	RS Means (2017)	33.12.16.20.1005	
Division 33 – Utilities	Air Release Valve for Water		1" inlet	$/EA	$ 139	1.32	$ 182.88	RS Means (2017)	33.12.16.20.1010	
Division 33 – Utilities	Air Release Valve for Water		2" inlet	$/EA	$ 345	1.32	$ 453.92	RS Means (2017)	33.12.16.20.1020	
Division 22 – Plumbing	Pipes		Reduced Pressure Backflow Preventor, flanged bronze (2-1/2")	$/EA	$ 5,875	1.32	$ 7,729.84	RS Means (2017)	22.11.19.42.5060	includes valves and four test cocks, corrosion resistant, automatic operation
Division 33 – Utilities	Pipes		Fire Hydrant (5.25" valve, 8ft deep)	$/EA	$ 3,250	1.32	$ 4,276.08	RS Means (2017)	33.12.19.10.2240	
Division 33 – Utilities	Pipes		Pipe Bedding Material	$/CY	$ 41.50	1.32	$ 54.60	RS Means (2017)	31.23.23.16.0100	not including compaction, loose
Division 33 – Utilities	Pipes		PVC Pipe Joint Restraint, 24" dia	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	33.11.13.25.8790	
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		4" Pipe	$/LF	$ 51	1.32	$ 67.10	RS Means (2017)	33.11.13.15.2020	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		6" Pipe	$/LF	$ 51	1.32	$ 67.10	RS Means (2017)	33.11.13.15.2040	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		8" Pipe	$/LF	$ 75	1.32	$ 98.68	RS Means (2017)	33.11.13.15.2060	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		10" Pipe	$/LF	$ 95	1.32	$ 124.34	RS Means (2017)	33.11.13.15.2080	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		12" Pipe	$/LF	$ 120	1.32	$ 157.89	RS Means (2017)	33.11.13.15.2100	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		14" Pipe	$/LF	$ 137	1.32	$ 180.25	RS Means (2017)	33.11.13.15.2120	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		16" Pipe	$/LF	$ 152	1.32	$ 199.99	RS Means (2017)	33.11.13.15.2140	cement lined, not including excavation or backfill
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		20" Pipe	$/LF	$ 201	1.32	$ 264.46	RS Means (2017)	33.11.13.15.2170	cement lined, not including excavation or backfill

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 33 – Utilities	DIP, Class 50, Mechanical Joint		24" Pipe	$/LF	$ 229	1.32	$ 301.30	RS Means (2017)	*33.11.13.15.2180*	cement lined, not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 18		4"	$/LF	$ 10	1.32	$ 12.50	RS Means (2017)	*33.11.13.25.4520*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 19		6"	$/LF	$ 13	1.32	$ 17.10	RS Means (2017)	*33.11.13.25.4530*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 20		8"	$/LF	$ 17	1.32	$ 22.89	RS Means (2017)	*33.11.13.25.4540*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 21		10"	$/LF	$ 24	1.32	$ 31.58	RS Means (2017)	*33.11.13.25.4550*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 22		12"	$/LF	$ 30	1.32	$ 39.47	RS Means (2017)	*33.11.13.25.4560*	not including excavation or backfill
Division 33 – Utilities	PVC, C900, Class 150, SDR 23		24"	$/LF	$ 60	1.32	$ 78.94	extrapolated		not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 25		14	$/LF	$ 25	1.32	$ 32.89	RS Means (2017)	*33.11.13.25.3030*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 26		16	$/LF	$ 32	1.32	$ 41.45	RS Means (2017)	*33.11.13.25.3040*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 27		18	$/LF	$ 40	1.32	$ 51.97	RS Means (2017)	*33.11.13.25.3050*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 28		20	$/LF	$ 49	1.32	$ 63.81	RS Means (2017)	*33.11.13.25.3060*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 29		24	$/LF	$ 68	1.32	$ 89.47	RS Means (2017)	*33.11.13.25.3070*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 30		30	$/LF	$ 115	1.32	$ 151.31	RS Means (2017)	*33.11.13.25.3080*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 31		36	$/LF	$ 163	1.32	$ 214.46	RS Means (2017)	*33.11.13.25.3090*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 32		42	$/LF	$ 201	1.32	$ 264.46	RS Means (2017)	*33.11.13.25.3100*	not including excavation or backfill
Division 33 – Utilities	PVC, C905 AWWA, DR 33		48	$/LF	$ 250	1.32	$ 328.93	RS Means (2017)	*33.11.13.25.3200*	not including excavation or backfill
Division 33 – Utilities	PVC with excavation, backfill and speed shoring		12	$/LF	$ 632	1.32	$ 832.17	RMC, not identified (2017)		Source for 139.5 ft of pipe; Jan 2017 CCI for SF
Division 33 – Utilities	Chemical Pipes		1-1/2" to 2"	$/LF	$ 92	1.32	$ 121.05	RS Means (2017)	*22.66.53.60.1000*	
Division 33 – Utilities	Chemical Pipes		2"	$/LF	$ 95	1.32	$ 124.99	RS Means (2017)	*22.66.53.60.1100*	
Division 33 – Utilities	Insulated Pipes - Chilled/HVAC Hot Water Distribtuion		2"	$/LF	$ 51	1.32	$ 66.44	RS Means (2017)	*33.61.13.10.1030*	
Division 33 – Utilities	Insulated Pipes - Chilled/HVAC Hot Water Distribtuion		8"	$/LF	$ 119	1.32	$ 156.57	RS Means (2017)	*33.61.13.10.1090*	
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		4"	$/LF	$ 11	1.32	$ 14.80	RS Means (2017)	*33.11.13.35.0100*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		6"	$/LF	$ 12	1.32	$ 16.25	RS Means (2017)	*33.11.13.35.0200*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		8"	$/LF	$ 19	1.32	$ 25.26	RS Means (2017)	*33.11.13.35.0300*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		10"	$/LF	$ 26	1.32	$ 33.55	RS Means (2017)	*33.11.13.35.0400*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		12"	$/LF	$ 36	1.32	$ 47.37	RS Means (2017)	*33.11.13.35.0500*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		14"	$/LF	$ 50	1.32	$ 65.13	RS Means (2017)	*33.11.13.35.0600*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		16"	$/LF	$ 60	1.32	$ 78.29	RS Means (2017)	*33.11.13.35.0700*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		18"	$/LF	$ 92	1.32	$ 121.05	RS Means (2017)	*33.11.13.35.0800*	not including excavation or backfill
Division 33 – Utilities	HDPE Pipes, SDR 21 butt fusion joints		24"	$/LF	$ 118	1.32	$ 155.25	RS Means (2017)	*33.11.13.35.0900*	not including excavation or backfill
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		10"	$/LF	$ 193	1.32	$ 253.93	RS Means (2017)	*22.11.13.48.1150*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		12"	$/LF	$ 218	1.32	$ 286.83	RS Means (2017)	*22.11.13.48.1160*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		14"	$/LF	$ 248	1.32	$ 326.30	RS Means (2017)	*22.11.13.48.1170*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		20"	$/LF	$ 425	1.32	$ 559.18	RS Means (2017)	*22.11.13.48.1200*	includes coupling &celvis type hanger assemblies
Division 22 – Plumbing	Steel Pipes, Schedule 40, black		24"	$/LF	$ 495	1.32	$ 651.28	RS Means (2017)	*22.11.13.48.1210*	includes coupling &celvis type hanger assemblies

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 09 – Finishes	Steel Pipes, Schedule 40, black		Exterior Steel Coating	$/SF	$ 1.01	1.32	$ 1.33	RS Means (2017)	*09.97.13.23.6910*	Universal primers, one part, phenolic, modified alkyd
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 8"x6"	$/EA	$ 540	1.32	$ 710.49	RS Means (2017)	*33.11.13.15.8460*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 10"x6"	$/EA	$ 690	1.32	$ 907.84	RS Means (2017)	*33.11.13.15.8470*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 12"x6"	$/EA	$ 880	1.32	$ 1,157.83	RS Means (2017)	*33.11.13.15.8480*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 14"x6"	$/EA	$ 1,103	1.32	$ 1,450.58	interpolated		
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 16"x6"	$/EA	$ 1,325	1.32	$ 1,743.33	RS Means (2017)	*33.11.13.15.8490*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		Reducer 20"x6"	$/EA	$ 2,175	1.32	$ 2,861.68	RS Means (2017)	*33.11.13.15.8500*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" 90 deg elbow	$/EA	$ 315	1.32	$ 414.45	RS Means (2017)	*33.11.13.15.8006*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" 90 deg elbow	$/EA	$ 435	1.32	$ 572.34	RS Means (2017)	*33.11.13.15.8020*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" 90 deg elbow	$/EA	$ 715	1.32	$ 940.74	RS Means (2017)	*33.11.13.15.8040*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" 90 deg elbow	$/EA	$ 985	1.32	$ 1,295.98	RS Means (2017)	*33.11.13.15.8060*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" 90 deg elbow	$/EA	$ 1,300	1.32	$ 1,710.43	RS Means (2017)	*33.11.13.15.8080*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		14" 90 deg elbow	$/EA	$ 1,825	1.32	$ 2,401.18	RS Means (2017)	*33.11.13.15.8100*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" 90 deg elbow	$/EA	$ 2,300	1.32	$ 3,026.15	RS Means (2017)	*33.11.13.15.8120*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		18" 90 deg elbow	$/EA	$ 3,100	1.32	$ 4,078.72	RS Means (2017)	*33.11.13.15.8140*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		20" 90 deg elbow	$/EA	$ 3,675	1.32	$ 4,835.26	RS Means (2017)	*33.11.13.15.8160*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		24" 90 deg elbow	$/EA	$ 5,350	1.32	$ 7,039.09	RS Means (2017)	*33.11.13.15.8180*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" tee or wye	$/EA	$ 635	1.32	$ 835.48	RS Means (2017)	*33.11.13.15.8200*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" tee or wye	$/EA	$ 895	1.32	$ 1,177.57	RS Means (2017)	*33.11.13.15.8220*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" tee or wye	$/EA	$ 1,300	1.32	$ 1,710.43	RS Means (2017)	*33.11.13.15.8240*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" tee or wye	$/EA	$ 1,750	1.32	$ 2,302.51	RS Means (2017)	*33.11.13.15.8260*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" tee or wye	$/EA	$ 2,375	1.32	$ 3,124.83	RS Means (2017)	*33.11.13.15.8280*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		14" tee or wye	$/EA	$ 3,550	1.32	$ 4,670.80	RS Means (2017)	*33.11.13.15.8300*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" tee or wye	$/EA	$ 4,075	1.32	$ 5,361.55	RS Means (2017)	*33.11.13.15.8320*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" cap	$/EA	$ 299	1.32	$ 393.40	RS Means (2017)	*33.11.13.15.6190*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		4" 45 deg elbow	$/EA	$ 425	1.32	$ 559.18	RS Means (2017)	*33.11.13.15.8398*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		6" 45 deg elbow	$/EA	$ 400	1.32	$ 526.29	RS Means (2017)	*33.11.13.15.8400*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		8" 45 deg elbow	$/EA	$ 540	1.32	$ 710.49	RS Means (2017)	*33.11.13.15.8405*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		10" 45 deg elbow	$/EA	$ 833	1.32	$ 1,095.33	interpolated		
Division 33 – Utilities	Fittings - DIP, AWWA C110		12" 45 deg elbow	$/EA	$ 1,125	1.32	$ 1,480.18	RS Means (2017)	*33.11.13.15.8410*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		16" 45 deg elbow	$/EA	$ 1,875	1.32	$ 2,466.97	RS Means (2017)	*33.11.13.15.8420*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		20" 45 deg elbow	$/EA	$ 2,875	1.32	$ 3,782.69	RS Means (2017)	*33.11.13.15.8430*	
Division 33 – Utilities	Fittings - DIP, AWWA C110		24" 45 deg elbow	$/EA	$ 3,925	1.32	$ 5,164.19	RS Means (2017)	*33.11.13.15.8440*	
Division 33 – Utilities	HDPE		4" 90 deg elbow	$/EA	$ 130	1.32	$ 171.04	RS Means (2017)	*33.11.13.35.1200*	
Division 33 – Utilities	HDPE		6" 90 deg elbow	$/EA	$ 177	1.32	$ 232.88	RS Means (2017)	*33.11.13.35.1300*	
Division 33 – Utilities	HDPE		8" 90 deg elbow	$/EA	$ 278	1.32	$ 365.77	RS Means (2017)	*33.11.13.35.1400*	
Division 33 – Utilities	HDPE		10" 90 deg elbow	$/EA	$ 555	1.32	$ 730.22	RS Means (2017)	*33.11.13.35.1500*	
Division 33 – Utilities	HDPE		12" 90 deg elbow	$/EA	$ 670	1.32	$ 881.53	RS Means (2017)	*33.11.13.35.1600*	
Division 33 – Utilities	HDPE		14" 90 deg elbow	$/EA	$ 1,050	1.32	$ 1,381.50	RS Means (2017)	*33.11.13.35.1700*	
Division 33 – Utilities	HDPE		16" 90 deg elbow	$/EA	$ 1,375	1.32	$ 1,809.11	RS Means (2017)	*33.11.13.35.1800*	
Division 33 – Utilities	HDPE		18" 90 deg elbow	$/EA	$ 1,875	1.32	$ 2,466.97	RS Means (2017)	*33.11.13.35.1900*	
Division 33 – Utilities	HDPE		24" 90 deg elbow	$/EA	$ 2,625	1.32	$ 3,453.76	RS Means (2017)	*33.11.13.35.2000*	
Division 33 – Utilities	HDPE		4" tee	$/EA	$ 142	1.32	$ 186.83	RS Means (2017)	*33.11.13.35.2200*	
Division 33 – Utilities	HDPE		6" tee	$/EA	$ 194	1.32	$ 255.25	RS Means (2017)	*33.11.13.35.2300*	
Division 33 – Utilities	HDPE		8" tee	$/EA	$ 305	1.32	$ 401.29	RS Means (2017)	*33.11.13.35.2400*	
Division 33 – Utilities	HDPE		10" tee	$/EA	$ 430	1.32	$ 565.76	RS Means (2017)	*33.11.13.35.2500*	
Division 33 – Utilities	HDPE		12" tee	$/EA	$ 880	1.32	$ 1,157.83	RS Means (2017)	*33.11.13.35.2600*	
Division 33 – Utilities	HDPE		14" tee	$/EA	$ 1,250	1.32	$ 1,644.65	RS Means (2017)	*33.11.13.35.2700*	
Division 33 – Utilities	HDPE		16" tee	$/EA	$ 1,575	1.32	$ 2,072.25	RS Means (2017)	*33.11.13.35.2800*	
Division 33 – Utilities	HDPE		4" cap	$/EA	$ 121	1.32	$ 159.20	RS Means (2017)	*33.11.13.35.4110*	
Division 33 – Utilities	HDPE		6" cap	$/EA	$ 153	1.32	$ 201.30	RS Means (2017)	*33.11.13.35.4120*	
Division 33 – Utilities	HDPE		8" cap	$/EA	$ 194	1.32	$ 255.25	RS Means (2017)	*33.11.13.35.4130*	
Division 33 – Utilities	HDPE		10" cap	$/EA	$ 365	1.32	$ 480.24	RS Means (2017)	*33.11.13.35.4150*	
Division 33 – Utilities	HDPE		12" cap	$/EA	$ 480	1.32	$ 631.54	RS Means (2017)	*33.11.13.35.4160*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" 45 deg elbow	$/EA	$ 68	1.32	$ 88.81	RS Means (2017)	*33.11.13.25.8200*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" 45 deg elbow	$/EA	$ 107	1.32	$ 140.78	RS Means (2017)	*33.11.13.25.8220*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" 45 deg elbow	$/EA	$ 202	1.32	$ 265.77	RS Means (2017)	*33.11.13.25.8240*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" 45 deg elbow	$/EA	$ 375	1.32	$ 493.39	RS Means (2017)	*33.11.13.25.8260*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" 45 deg elbow	$/EA	$ 495	1.32	$ 651.28	RS Means (2017)	*33.11.13.25.8280*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		24" 45 deg elbow	$/EA	$ 990	1.32	$ 1,302.56	extrapolated		

Division	Category	Sizing	Description (Asset)	Unit	Raw Unit Cost	Cost Adj. Factor (CCI and Location)	Adjusted Unit Cost	Cost Source	RS Means Reference #	Notes
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" 90 deg elbow	$/EA	$ 68	1.32	$ 88.81	RS Means (2017)	*33.11.13.25.8006*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" 90 deg elbow	$/EA	$ 110	1.32	$ 144.73	RS Means (2017)	*33.11.13.25.8020*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" 90 deg elbow	$/EA	$ 196	1.32	$ 257.88	RS Means (2017)	*33.11.13.25.8040*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" 90 deg elbow	$/EA	$ 440	1.32	$ 578.92	RS Means (2017)	*33.11.13.25.8060*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" 90 deg elbow	$/EA	$ 570	1.32	$ 749.96	RS Means (2017)	*33.11.13.25.8080*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		4" tee	$/EA	$ 89	1.32	$ 116.44	RS Means (2017)	*33.11.13.25.8100*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		6" tee	$/EA	$ 178	1.32	$ 234.20	RS Means (2017)	*33.11.13.25.8120*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		8" tee	$/EA	$ 248	1.32	$ 326.30	RS Means (2017)	*33.11.13.25.8140*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		10" tee	$/EA	$ 760	1.32	$ 999.95	RS Means (2017)	*33.11.13.25.8160*	
Division 33 – Utilities	PVC, Class 150, DR 18, Fitting with Rubber Gasket		12" tee	$/EA	$ 1,025	1.32	$ 1,348.61	RS Means (2017)	*33.11.13.25.8180*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		4" tee	$/EA	$ 200	1.32	$ 263.14	RS Means (2017)	*22.11.13.48.4800*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		5" tee	$/EA	$ 385	1.32	$ 506.55	RS Means (2017)	*22.11.13.48.4810*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		6" tee	$/EA	$ 450	1.32	$ 592.07	RS Means (2017)	*22.11.13.48.4820*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		8" tee	$/EA	$ 860	1.32	$ 1,131.52	RS Means (2017)	*22.11.13.48.4830*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		12" tee	$/EA	$ 1,400	1.32	$ 1,842.00	RS Means (2017)	*22.11.13.48.4850*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		14" tee	$/EA	$ 1,500	1.32	$ 1,973.58	RS Means (2017)	*22.11.13.48.4851*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		16" tee	$/EA	$ 1,675	1.32	$ 2,203.83	RS Means (2017)	*22.11.13.48.4852*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		20" tee	$/EA	$ 2,900	1.32	$ 3,815.58	RS Means (2017)	*22.11.13.48.4854*	
Division 22 – Plumbing	Steel Pipe, Fittings are Ductile Iron		24" tee	$/EA	$ 4,250	1.32	$ 5,591.80	RS Means (2017)	*22.11.13.48.4855*	
Division 02 – Site Construction	Demolition and Removal		Disposal (offsite)	$/CY	$ 19.20	1.32	$ 25.26	RS Means (2017)	*02.41.16.17.4250*	up to five miles away
Division 31 – Earthwork	Demolition and Removal		Offhaul, 8 C.Y. Truck	$/CY	$ 5.10	1.32	$ 6.71	RS Means (2017)	*31.23.23.20.0044*	8 CY truck, 25 mph ave., cycle 4 miles
Division 02 – Site Construction	Demolition and Removal		C&D Dumping and Hauling Fees	$/CY	$ 70.63	1.32	$ 93.37	RS Means / SF project (2016)		$55/cy fee from Redwood landfill. Fee is $45/ton if waste needs to comply with Marin County's recycling ordanance. If waste is 2 cy/ton fee would be $90/ton
Division 02 – Site Construction	Demolition and Removal		Patch Walls	$/SF	$ 1.50	1.32	$ 1.98	estimate		
Division 02 – Site Construction	Demolition and Removal		Concrete Slab	$/SF	$ 0.99	1.32	$ 1.30	RS Means (2017)	*02.41.16.17.0440*	
Division 02 – Site Construction	Demolition and Removal		Concrete Elevated Slab	$/CY	$ 35.50	1.32	$ 46.71	RS Means (2017)	*02.41.19.16.0050*	
Division 02 – Site Construction	Demolition and Removal		Concrete Wall	$/SF	$ 1.43	1.32	$ 1.88	RS Means (2017)	*02.41.16.17.2500*	12" thick
Division 02 – Site Construction	Demolition and Removal		Bituminous Pavement Removal	$/SY	$ 9.80	1.32	$ 12.89	RS Means (2017)	*02.41.13.17.5050*	
Division 02 – Site Construction	Demolition and Removal		Concrete Pavement Removal	$/SY	$ 16.15	1.32	$ 21.25	RS Means (2017)	*02.41.13.17.5200*	
Division 02 – Site Construction	Demolition and Removal		Concrete Curb Removal	$/LF	$ 7.20	1.32	$ 9.47	RS Means (2017)	*02.41.13.17.6100*	
Division 02 – Site Construction	Demolition and Removal		Building Demolition	$/SF of floor	$ 2.78	1.32	$ 3.66	RS Means (2017)	*13.05.05.50.0550*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 275 gal	$/EA	$ 450	1.32	$ 592.07	RS Means (2017)	*13.05.05.75.0510*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 550-2200 gal	$/EA	$ 1,325	1.32	$ 1,743.33	RS Means (2017)	*13.05.05.75.0520*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 5000-10000 gal	$/EA	$ 1,625	1.32	$ 2,138.04	RS Means (2017)	*13.05.05.75.0530*	
Division 02 – Site Construction	Demolition and Removal		Steel Tank Demo, 15000-30000 gal	$/EA	$ 3,250	1.32	$ 4,276.08	RS Means (2017)	*13.05.05.75.0540*	
Division 02 – Site Construction	Demolition and Removal		Piping, 4"-6"	$/LF	$ 14.90	1.32	$ 19.60	RS Means (2017)	*22.05.05.10.2100*	
Division 02 – Site Construction	Demolition and Removal		Piping, 8"-14"	$/LF	$ 25.00	1.32	$ 32.89	RS Means (2017)	*22.05.05.10.2150*	
Division 02 – Site Construction	Demolition and Removal		Piping, 16"-20"	$/LF	$ 31.00	1.32	$ 40.79	RS Means (2017)	*22.05.05.10.2153*	
Division 02 – Site Construction	Demolition and Removal		Piping, 24"-26"	$/LF	$ 39.50	1.32	$ 51.97	RS Means (2017)	*22.05.05.10.2155*	
Division 02 – Site Construction	Demolition and Removal		Piping, 30"-36"	$/LF	$ 54.00	1.32	$ 71.05	RS Means (2017)	*22.05.05.10.2156*	
Division 02 – Site Construction	Demolition and Removal		Ductwork, 30" H, 26" W	$/LF	$ 8.55	1.32	$ 11.25	RS Means (2017)	*23.05.05.10.1500*	
Division 31 – Earthwork	Dewatering			$/DAY	$ 1,091	1.00	$ 1,091.22	RS Means (2019) - raw unit costs have location factor embedded in it	31.23.19.20.1000	8 hours with 4" diaphragm pump, labor included
Division 31 – Earthwork	Dewatering			$/DAY	$ 272.81	1.32	$ 358.93	RS Means (2017)	31.23.19.20.1020	Add 2 additional pumps
Division 31 – Earthwork	Dewatering			$/DAY	$ 4,092	1.03	$ 4,204.60	RMC, not identified (2017)		Total for 24 hours, 3 pumps
Division 31 – Earthwork	Microtunneling			$/inch-diam per LF of casing	$ 48.00	1.03	$ 49.32	RMC, not identified (2017)		
Division 31 – Earthwork	Microtunneling		Launch Shaft		$ 300,000	1.03	$ 308,249.42	RMC, not identified (2017)		
Division 31 – Earthwork	Microtunneling		Reception Shaft		$ 150,000	1.03	$ 154,124.71	RMC, not identified (2017)		

Exhibit 2: R&R Values Used from Valley Water

This exhibit provides a list of the R&R values used from the v.65 export of Valley Water's asset management database. As requested by Valley Water, the "cell reference" column indicates the location of the cell in the exported file, and the "ID" column indicates the relevant asset's ID.

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Exhibit 2: Asset Types, Classes, and R&R Basis

Asset Class ID	Asset Type	Asset Class	Replacement Cycle (Years)	Renewal Cycle (Years)	Renewal Costs (Percent)	Valley Water Asset ID	Basis of Recommendation
AC 1	Site Improv	Roadways and Walkways	75	30	25%	L17	Replacement - Valley Water asset database; Renewal - Expedited Purified Water Program
AC 2	Site Improv	Metals and Fencing	75	0	0%	L12	Valley Water asset database
AC 3	Earthwork	Subgrade Structural Piles	70	30	25%		Expedited Purified Water Program
AC 4	Concrete	Above/Below Grade (slabs, pads, vaults, etc.)	100	25	25%		Expedited Purified Water Program
AC 5	Equipment	Pumps, Chemical metering	10	0	0%	PU21	Valley Water asset database
AC 6	Equipment	Pumps, Process/Product, 25-50 HP submersible	15	0	0%	PU25	Valley Water asset database
AC 7	Equipment	Pumps, Process/Product, 25-75 HP	20	10	30%	PU12	Replacement - Valley Water asset databaseRenewal - Expedited Purified Water Program
AC 8	Equipment	Pumps, Process/Product, 100-200 HP	30	15	30%	PU14	Valley Water asset database
AC 9	Equipment	Flow Meters	10	0	0%	FE7	Valley Water asset database
AC 10	Equipment	Static Mixers	40	0	0%	MX5	Valley Water asset database
AC 11	Equipment	Tanks, Process (steel)	50	20	30%		Expedited Purified Water Program
AC 12	Equipment	Ozone system	50	25	75%		Engineer's Estimate
AC 13	Equipment	Biologically activated carbon (BAC) system	50	25	75%		Engineer's Estimate
AC 14	Equipment	UF system	50	25	75%		Engineer's Estimate
AC 15	Equipment	RO System	50	25	75%		Engineer's Estimate
AC 16	Equipment	Decarbonator System	40	20	20%		Expedited Purified Water Program
AC 17	Equipment	UV System	50	25	75%		Engineer's Estimate
AC 18	Structures/	Process Building (prefabricated steel, single story)	75	0	0%	BU3	Valley Water asset database
AC 19	Structures/	Canopies, Steel	75	0	0%		Expedited Purified Water Program
AC 20	Chemical Ta	Tanks, Chemical (carbon steel, vertical)	40	8	20%	TK22	Replacement - Valley Water asset databaseRenewal - Expedited Purified Water Program
AC 21	Chemical Ta	Tanks, Chemical (fiberglass reinforced plastic, vertical)	25	8	20%		Expedited Purified Water Program
AC 22	Chemical Ta	Tanks, Chemical (high-density polyethylene, vertical)	25	8	20%		Expedited Purified Water Program
AC 23	Mechanical	Piping, Conveyance	100	20	4%		Expedited Purified Water Program
AC 24	Mechanical	Piping, Process (stainless steel or equivalent)	100	0	0%		Replacement - Expedited Purified Water Program; Renewal - Standard industry sources
AC 25	Mechanical	Valves	30	0	0%		Expedited Purified Water Program
AC 26	Electrical	Electrical Equipment and Accessories	25	0	0%	CP6	Valley Water asset database
AC 27	Instrumenta	Instrumentation (except flow meters)	20	0	0%		Expedited Purified Water Program
AC 28	N/A	NO CAPITAL/R&R COST	0	0	0%		
AC 29	Equipment	Pumps, Process/Product, >200 HP	50	25	30%	PU6	Valley Water asset database
AC 30	Equipment	MBR System	50	25	75%		Engineer's Estimate
AC 31	Concrete	Concrete water tank	100	20	1%	TK 39	DN Tanks vendor proposal

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Appendix A-6: Cost Estimates

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List of Tables

Cost estimates summary

Table 1. Overview of Capital and Annual O&M Costs for North County Portfolios and South County Reuse Options 5

Project elements for each portfolio/option

Portfolio 1a cost estimate details 9

Table 2. San José AWPF; 24 mgd for GWR (Portfolio 1a) 9

Table 3. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1a) 14

Table 4. PL-2, 48-inch purified water pipeline from San José AWPF to Los Gatos Recharge Ponds (LGRP) (Portfolio 1a) 15

Table 5. PS-1, pump station to convey San José AWPF purified water to LGRP (Portfolio 1a) 16

Table 6. LGRP site improvements (Portfolio 1a) 18

Portfolio 1b cost estimate details 22

Table 7. San José AWPF; 24 mgd for RWA (Portfolio 1b) 22

Table 8. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1b) 28

Table 9. PL-4, 48-inch purified water pipeline from San José AWPF to Penitencia WTP (Portfolio 1b) 29

Table 10. PS-2, pump station to convey San José AWPF purified water to Penitencia WTP (Portfolio 1b) 30

Table 11. Penitencia WTP site improvements (Portfolio 1b) 32

Portfolios 1c and 1d cost estimate details 35

Table 12. San José AWPF; 24 mgd for TWA (Portfolios 1c and 1d) 35

Table 13. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolios 1c and 1d) 41

Table 14. PL-40, 36-inch purified water pipeline from San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus (Portfolio 1c) 42

Table 15. PL-41, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolio 1c) 43

Table 16. PS-14, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-40 and Milpitas Pipeline (Portfolios 1c) 44

Table 17. PS-15, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolios 1c) 46

Table 18. PL-42, 36-inch purified water pipeline from San José AWPF to modulating valve vault at Penitencia WTP (Portfolio 1d) 48

Table 19. PL-43, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolios 1d) 49

Table 20. PS-16, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-42 (Portfolio 1d) 50

Table 21. PS-17, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolio 1d) 52

Portfolio 2a cost estimate details 54

Table 22. Combined Regional AWPF in Palo Alto; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2a) 54

Table 23. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 2a) 59

Table 24. PL-6, 36-inch effluent pipeline from Sunnyvale WPCP to Palo Alto AWPF (Portfolio 2a) 60

Table 25. PL-7, 48-inch purified water pipeline from Palo Alto AWPF to LGRP (Portfolio 2a) 61

Table 26. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 2a) 62

Table 27. PS-4, pump station to convey Sunnyvale WPCP effluent to Palo Alto AWPF (Portfolio 2a) 64

Table 28. PS-5, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 2a) 66

Table 29. LGRP site improvements (Portfolio 2a) 68

Portfolio 2b cost estimate details 72

Table 30. Combined Regional AWPF in Sunnyvale; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2b) 72

Table 31. PL-8, 36-inch effluent pipeline from Palo Alto RWQCP to Sunnyvale AWPF (Portfolio 2b) 77

Table 32. PL-9, 48-inch purified water pipeline from Sunnyvale AWPF to LGRP (Portfolio 2b) 78

Table 33. PS-6, pump station to convey Palo Alto RWQCP effluent to Sunnyvale AWPF (Portfolio 2b) 79

Table 34. PS-7, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 2b) 81

Table 35. LGRP site improvements (Portfolio 2b) 83

Portfolio 4 cost estimate details 87

Table 36. Separate Regional AWPF in Palo Alto; 14 mgd for GWR (Portfolio 4) 87

Table 37. Separate Regional AWPF in Sunnyvale; 10 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 4) 92

Table 38. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 4) 97

Table 39. PL-10, 36-inch purified water pipeline from Palo Alto AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4) 98

Table 40. PL-11, 48-inch purified water pipeline from Joint Purified Water Pipeline to LGRP (Portfolio 4) 99

Table 41. PL-12, 36-inch purified water pipeline from Sunnyvale AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4) 100

Table 42. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 4) 101

Table 43. PS-9, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 4) 103

Table 44. PS-10, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 4) 105

Table 45. LGRP site improvements (Portfolio 4) 107

Morgan Hill options cost estimate details 111

Table 46. PL-35, 16-inch NPR+ pipeline from Metcalf Energy Center to Burnett Road at Monterey (Morgan Hill Option 1) 111

Table 47. Satellite WWTP and AWPF, 2.5 mgd for GWR (Morgan Hill Option 2) 112

Table 48. PS-13, pump station to convey Morgan Hill AWPF purified water to San Pedro Recharge Ponds (Morgan Hill Option 2) 117

Table 49. PL-25, 16-inch purified water pipeline from Morgan Hill AWPF to San Pedro Recharge Ponds (Morgan Hill Option 2) 119

Table 50. Satellite WWTP and AWPF, 2.5 mgd for GWR (Morgan Hill Option 3) 120

Table 51. PS-11, pump station to convey Morgan Hill AWPF purified water to the booster pump station (Morgan Hill Option 3) 125

Table 52. PS-12, pump station to convey purified water from the booster pump station to Anderson Reservoir (Morgan Hill Option 3) 127

Table 53. PL-26, 16-inch purified water pipeline from Morgan Hill AWPF to Anderson Reservoir (Morgan Hill Option 3) 129

Future opportunities and alternative elements cost estimate details

Table 54. NPR+ AWPFs....130

Table 55. Purified water pipeline extension from LGRP to Rinconada WTP for RWA (PL-36; Portfolios 1a, 2a, 2b, and/or 4)....131

Table 56. NPR+ intertie between Mountain View and Sunnyvale 132

Table 57. NPR+ intertie between Sunnyvale and SBWR....133

Table 58. PL-15, 36-inch purified water pipeline from Moffett Field to Sunnyvale WPCP....134

Table 59. PL-16, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East) 135

Table 60. PL-17, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East) 136

Table 61. PL-18, 36-inch purified water pipeline from Moffett Field to Arques (West) 137

Table 62. PL-19, 36-inch purified water pipeline from Arques (West) to Arques (East) 138

Table 63. PL-20, 48-inch purified water pipeline from Arques (West) to Arques (East) 139

Table 64. PL-31, 48-inch purified water pipeline from Sunnyvale WPCP to LGRP....140

Table 65. PL-32, 48-inch purified water pipeline from Arques (West) to LGRP....141

Table 66. PL-33, 36-inch purified water pipeline from Palo Alto AWPF to Sunnyvale WPCP....142

Table 67. PL-44, 36-inch pipeline from PA AWPF to West Pipeline at Stevens Creek Blvd (West County TWA) 143

Table 68. Westside AWPF (West County Treated Water Augmentation)....144

Table 69. PS-18, pump station to convey Palo Alto AWPF purified water to West Pipeline at Stevens Creek (West County TWA) 150

Lifecycle Costs

Table 70. Life-cycle cost for Portfolio 1a 151

Table 71. Life-cycle cost for Portfolio 1b 154

Table 72. Life-cycle cost for Portfolio 1c 157

Table 73. Life-cycle cost for Portfolio 1d 160

Table 74. Life-cycle cost for Portfolio 2a 163

Table 75. Life-cycle cost for Portfolio 2b 166
Table 76. Life-cycle cost for Portfolio 4 169
Table 77. Life-cycle cost for Morgan Hill Option 1 (NPR+ from SBWR) 172
Table 78. Life-cycle cost for Morgan Hill Option 2 (GWR) 175
Table 79. Life-cycle cost for Morgan Hill Option 3 (SWA) 178

Cost estimates summary

Table 1. Overview of Capital and Annual O&M Costs for North County Portfolios and South County Reuse Options

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Production capacity (mgd)	Horsepower (hp)	Length		Annual Purified Water Yield[a] (AFY)		Total Estimated Cost[b,c] ($M)		Rounded Estimate[b,c] ($M)	
								(LF)	(miles)	Lower bound	Upper bound	Capital	Annual O&M	Capital	Annual O&M
1a - PORTFOLIO SUMMARY															
Table 2	AWPF-1a	AWPF for GWR	San José	–	–	24.0	–	–	–	–	–	$ 319	$ 13.7	$ 320	$ 13.8
Table 3	PL-1	Effluent Pipeline (PL)	SJ/SC RWF	San José AWPF	60	–	–	2,000	0.4	–	–	$ 6	$ 0.0	$ 320	$ 3.5
Table 4	PL-2	Purified Water PL	San José AWPF	LGRP	48	–	–	95,490	18.1	–	–	$ 264	$ 0.2		
Table 5	PS-1	Purified Water Pump Station (PS)	San José AWPF	LGRP	–	24.0	2,877	–	–	–	–	$ 28	$ 2.9		
Table 6	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	–	–	$ 15	$ 0.4		
–	PL Easements	Easement[d]	SJ/SC RWF	–	–	–	–	97,490	18.5	–	–	$ 3	$ -		
–	Source water	Purchased supply for reuse[e]	SJ/SC RWF	–	–	–	–	–	–	19,000	24,000	$ -	$ 2.4	$ -	$ 2.4
Subtotal - Excluding ROCM														$ 640	$ 19.7
–	ROCM-1a	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 19	$ 1.8	$ 20	$ 1.8
TOTAL														**$ 660**	**$ 21.5**
1b - PORTFOLIO SUMMARY															
Table 7	AWPF-1b	AWPF for RWA	San José	–	–	24.0	–	–	–	–	–	$ 382	$ 16.0	$ 385	$ 16.0
Table 8	PL-1	Effluent PL	SJ/SC RWF	San José AWPF	60	–	–	2,000	0.4	–	–	$ 6	$ 0.0	$ 245	$ 4.4
Table 9	PL-4	Purified Water PL	San José AWPF	Penitencia WTP	48	–	–	47,100	8.9	–	–	$ 135	$ 0.1		
Table 10	PS-2	Purified Water PS	San José AWPF	Penitencia WTP	–	24.0	3,977	–	–	–	–	$ 37	$ 3.9		
Table 11	PEN-1	Penitencia Site Improvements[f]	–	–	–	–	–	–	–	–	–	$ 55	$ 0.3		
–	PL Easements	Easement[d]	–	–	–	–	–	49,100	9.3	–	–	$ 11	$ -		
–	Source water	Purchased supply for reuse[e]	SJ/SC RWF	–	–	–	–	–	–	19,800	24,000	$ -	$ 2.4	$ -	$ 2.4
Subtotal - Excluding ROCM														$ 630	$ 22.8
–	ROCM-1b	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 19	$ 1.8	$ 20	$ 1.8
TOTAL														**$ 650**	**$ 24.6**
1c - PORTFOLIO SUMMARY															
Table 12	AWPF-1c/d	AWPF for TWA	San José	–	–	24.0	–	–	–	–	–	$ 393	$ 16.3	$ 395	$ 16.3
Table 13	PL-1	Effluent PL	SJ/SC RWF	San José AWPF	60	–	–	2,000	0.4	–	–	$ 6	$ 0.0	$ 140	$ 3.6
Table 14	PL-40	Purified Water PL	San José AWPF	Penitencia WTP	36	–	–	20,800	3.9	–	–	$ 42	$ 0.0		
Table 15	PL-41	Purified Water PL	San José AWPF	Santa Clara	24	–	–	24,700	4.7	–	–	$ 32	$ 0.0		
Table 16	PS-14	Purified Water PS	San José AWPF	Penitencia WTP	–	24.0	2,500	–	–	–	–	$ 33	$ 2.5		
Table 17	PS-15	Purified Water PS	San José AWPF	Santa Clara	–	12.0	890	–	–	–	–	$ 16	$ 0.9		
–	PL Easements	Easement[d]	–		–	–	–	47,500	8.6	–	–	$ 11	$ -		
–	Source water	Purchased supply for reuse[e]	SJ/SC RWF	–	–	–	–	–	–	24,000	24,000	$ -	$ 2.4	$ -	$ 2.4
Subtotal - Excluding ROCM														$ 535	$ 22.3
–	ROCM-1c	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 19	$ 1.8	$ 20	$ 1.8
TOTAL														**$ 555**	**$ 24.1**
1d - PORTFOLIO SUMMARY															
Table 12	AWPF-1c/d	AWPF for TWA	San José	–	–	24.0	–	–	–	–	–	$ 393	$ 16.3	$ 395	$ 16.3
Table 13	PL-1	Effluent PL	SJ/SC RWF	San José AWPF	60	–	–	2,000	0.4	–	–	$ 6	$ 0.0	$ 190	$ 3.6
Table 18	PL-42	Purified Water PL	San José AWPF	Penitencia WTP	36	–	–	43,100	8.2	–	–	$ 86	$ 0.1		
Table 19	PL-43	Purified Water PL	San José AWPF	Santa Clara	24	–	–	24,700	4.7	–	–	$ 32	$ 0.0		
Table 20	PS-16	Purified Water PS	San José AWPF	Penitencia WTP	–	24.0	2,500	–	–	–	–	$ 33	$ 2.5		
Table 21	PS-17	Purified Water PS	San José AWPF	Santa Clara	–	12.0	890	–	–	–	–	$ 16	$ 0.9		
–	PL Easements	Easement[d]	–	–	–	–	–	69,800	12.8	–	–	$ 16	$ -		
–	Source water	Purchased supply for reuse[e]	SJ/SC RWF	–	–	–	–	–	–	24,000	24,000	$ -	$ 2.4	$ -	$ 2.4
TOTAL - Excluding ROCM														$ 585	$ 22.3
–	ROCM-1d	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 19	$ 1.8	$ 20	$ 1.8
TOTAL														**$ 605**	**$ 24.1**

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Production capacity (mgd)	Horsepower (hp)	Length		Annual Purified Water Yield[a] (AFY)		Total Estimated Cost[b,c] ($M)		Rounded Estimate[b,c] ($M)	
								(LF)	(miles)	Lower bound	Upper bound	Capital	Annual O&M	Capital	Annual O&M
2a - PORTFOLIO SUMMARY															
Table 22	AWPF-2a	AWPF for GWR	Palo Alto	–	–	24.5	–	–	–	–	–	$ 306	$ 13.6	$ 310	$ 13.6
Table 23	PL-5	Effluent PL	Palo Alto RWQCP	Palo Alto AWPF	36	–	–	15,150	2.9	–	–	$ 29	$ 0.0	$ 455	$ 5.1
Table 24	PL-6	Effluent PL	Sunnyvale WPCP	Palo Alto AWPF	36	–	–	38,820	7.4	–	–	$ 75	$ 0.1		
Table 25	PL-7	Purified Water PL	Palo Alto AWPF	LGRP	48	–	–	107,400	20.3	–	–	$ 293	$ 0.2		
Table 26	PS-3	Effluent PS	Palo Alto RWQCP	Palo Alto AWPF	–	17.3	508	–	–	–	–	$ 4	$ 0.6		
Table 27	PS-4	Effluent PS	Sunnyvale WPCP	Palo Alto AWPF	–	11.5	400	–	–	–	–	$ 4	$ 0.4		
Table 28	PS-5	Purified Water PS	Palo Alto AWPF	LGRP	–	24.0	2,877	–	–	–	–	$ 28	$ 3.4		
Table 29	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	–	–	$ 15	$ 0.4		
–	PL Easements	Easement[d]	–	–	–	–	–	161,370	30.6	–	–	$ 5	$ -		
–	Source water	Purchased supply for reuse[e]	PA RWQCP and SV WPCP	–	–	–	–	–	–	17,000	23,000	$ -	$ 2.3	$ -	$ 2.3
Subtotal - Excluding ROCM														$ 765	$ 21.0
–	ROCM-2a	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 34	$ 1.5	$ 35	$ 1.6
TOTAL														**$ 800**	**$ 22.6**
2b - PORTFOLIO SUMMARY															
Table 30	AWPF-2b	AWPF for GWR	Sunnyvale	–	–	24.5	–	–	–	–	–	$ 316	$ 13.5	$ 360	$ 13.6
–	Recycle Hill Site Prep[g]	Geotech			–	24.5	–	–	–	–	–	$ 44	$ -		
Table 31	PL-8	Effluent PL	Palo Alto RWQCP	Sunnyvale AWPF	36	–	–	52,950	10.0	–	–	$ 103	$ 0.1	$ 405	$ 4.1
Table 32	PL-9	Purified Water PL	Sunnyvale AWPF	LGRP	48	–	–	90,230	17.1	–	–	$ 249	$ 0.1		
Table 33	PS-6	Effluent PS	Palo Alto RWQCP	Sunnyvale AWPF	–	17.3	508	–	–	–	–	$ 4	$ 0.6		
Table 34	PS-7	Purified Water PS	Sunnyvale AWPF	LGRP	–	24.0	2,877	–	–	–	–	$ 28	$ 2.9		
Table 35	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	–	–	$ 15	$ 0.4		
–	PL Easements	Easement[d]	–	–	–	–	–	143,180	27.1	–	–	$ 5	$ -		
–	Source water	Purchased supply for reuse[e]	PA RWQCP and SV WPCP	–	–	–	–	–	–	17,000	23,000	$ -	$ 2.3	$ -	$ 2.3
Subtotal - Excluding ROCM														$ 765	$ 20.0
–	ROCM-2b	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 37	$ 1.6	$ 40	$ 1.6
TOTAL														**$ 805**	**$ 21.6**
4 - PORTFOLIO SUMMARY															
Table 36	AWPF-4 (1 of 2)	AWPF for GWR	Palo Alto	–	–	14.0	–	–	–	–	–	$ 205	$ 8.4	$ 205	$ 8.5
Table 37	AWPF-4 (2 of 2)	AWPF for GWR	Sunnyvale	–	–	10.5	–	–	–	–	–	$ 172	$ 6.4	$ 220	$ 6.4
–	Recycle Hill Site Prep[g]	Geotech			–	24.5	–	–	–	–	–	$ 44	$ -		
Table 38	PL-5	Effluent PL	Palo Alto RWQCP	Palo Alto AWPF	36	–	–	15,150	2.9	–	–	$ 29	$ 0.0	$ 385	$ 4.2
Table 39	PL-10	Purified Water PL	Palo Alto AWPF	Joint Purified Water PL	36	–	–	34,500	6.5	–	–	$ 67	$ 0.1		
Table 40	PL-11	Purified Water PL	Joint Purified Water PL	LGRP	48	–	–	72,500	13.7	–	–	$ 198	$ 0.1		
Table 41	PL-12	Purified Water PL	Sunnyvale AWPF	Joint Purified Water PL	36	–	–	11,400	2.2	–	–	$ 22	$ 0.0		
Table 42	PS-3	Effluent PS	Palo Alto RWQCP	Palo Alto AWPF	–	17.3	508	–	–	–	–	$ 4	$ 0.6		
Table 43	PS-9	Purified Water PS	Palo Alto AWPF	LGRP	–	14.0	1,650	–	–	–	–	$ 21	$ 1.7		
Table 44	PS-10	Purified Water PS	Sunnyvale AWPF	LGRP	–	10.0	1,200	–	–	–	–	$ 19	$ 1.2		
Table 45	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	–	–	$ 15	$ 0.4		
–	PL Easements	Easement[d]	–	–	–	–	–	133,550	25.3	–	–	$ 4	$ -		
–	Source water	Purchased supply for reuse[e]	PA RWQCP	–	–	–	–	–	–	11,700	13,200	$ -	$ 1.3	$ -	$ 1.4
–	Source water	Purchased supply for reuse[e]	SV WPCP	–	–	–	–	–	–	5,500	9,800	$ -	$ 1.0	$ -	$ 1.0
Subtotal - Palo Alto components only (Excluding ROCM)														$ 545	$ 12.6
Subtotal - Remaining Sunnyvale components (Excluding ROCM)														$ 260	$ 8.7
Subtotal - Palo Alto and Sunnyvale, Excluding ROCM														$ 810	$ 21.5
–	ROCM-4	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 40.3	$ 1.6	$ 45	$ 1.6
TOTAL														**$ 855**	**$ 23.1**

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Production capacity (mgd)	Horsepower (hp)	Length		Annual Purified Water Yield[a] (AFY)		Total Estimated Cost[b,c] ($M)		Rounded Estimate[b,c] ($M)	
								(LF)	(miles)	Lower bound	Upper bound	Capital	Annual O&M	Capital	Annual O&M
Morgan Hill - Option 1 (NPR+ from SBWR)															
Table 46	PL-35	Recycled Water PL	Metcalf Energy Center	Burnett Road at Monterey	16	5	–	31,500	6.0	–	–	$ 28	$ 0.1	$ 30	$ 0.1
–	PL Easements	Easement[d]	–	–	–	–	–	31,500	6.0	–	–	$ 1	$ -		
–	NPR+ Distribution	Morgan Hill NPR+ distribution system	Burnett Road at Monterey	–	–	–	–	86,700	16.4	–	–	$ 37	$ 0.7	$ 40	$ 0.7
–	Source water	Purchased supply for reuse[e]	SJ/SC RWF	–	–	–	–	–	–	2,900	2,900	$ -	$ 1.7	$ -	$ 1.8
TOTAL														**$ 70**	**$ 2.6**
Morgan Hill - Option 2 (GWR)															
Table 47	MH-Satellite	Satellite WWTP and AWPF for GWR	MH trunk line	–	–	2.5	–	–	–	–	–	$ 59	$ 6.6	$ 60	$ 6.6
Table 48	PS-13	Purified Water PS	MH AWPF	San Pedro	–	2.1	78	–	–	–	–	$ 1	$ 0.1	$ 15	$ 0.2
Table 49	PL-25	Purified Water PL	MH AWPF	San Pedro	16	–	–	14,600	2.8	–	–	$ 13	$ 0.0		
–	PL Easements	Easement[d]	–	–	–	–	–	14,600	2.8	–	–	$ 1	$ -		
–	Source water	Purchased supply for reuse[e]	MH trunk line	–	–	–	–	–	–	1,900	1,900	$ -	$ -	$ -	$ -
Subtotal - Excluding ROCM														$ 75	$ 6.8
–	ROCM-MH	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 49	$ 0.1	$ 50	$ 0.1
TOTAL														**$ 125**	**$ 6.9**
Morgan Hill - Option 3 (SWA)															
Table 50	MH-Satellite	Satellite WWTP and AWPF for SWA	MH trunk line	–	–	2.5	–	–	–	–	–	$ 59	$ 6.6	$ 60	$ 6.6
Table 51	PS-11	Purified Water PS	MH AWPF	Booster PS	–	2.1	231	–	–	–	–	$ 3	$ 0.2	$ 35	$ 0.5
Table 52	PS-12	Purified Water PS	Booster PS	Anderson	–	2.1	218	–	–	–	–	$ 2	$ 0.2		
Table 53	PL-26	Purified Water PL	MH AWPF	Anderson	16	–	–	29,400	5.6	–	–	$ 26	$ 0.0		
–	PL Easements	Easement[d]	–	–	–	–	–	29,400	5.6	–	–	$ 1	$ -		
–	Source water	Purchased supply for reuse[e]	MH trunk line	–	–	–	–	–	–	1,900	1,900	$ -	$ -	$ -	$ -
TOTAL - Excluding ROCM														$ 95	$ 7.1
–	ROCM-MH	ROCM strategy	–	–	–	–	–	–	–	–	–	$ 49	$ 0.1	$ 50	$ 0.1
TOTAL														**$ 145**	**$ 7.2**

Table no. in Appendix A-6	ID no.	Project element	Location or start point	End point	Diameter (in)	Production capacity (mgd)	Horsepower (hp)	Length		Annual Purified Water Yield[a] (AFY)		Total Estimated Cost[b,c] ($M)		Rounded Estimate[b,c] ($M)	
								(LF)	(miles)	Lower bound	Upper bound	Capital	Annual O&M	Capital	Annual O&M
West County TWA (potential future opportunity)															
Table 68	Westside TWA	AWPF	San José	–	–	24.0	–	–	–	–	–	$ 380	$ 16.2	$ 380	$ 16.2
Table 23	PL-5	Effluent PL	Palo Alto RWQCP	Palo Alto AWPF	36	–	–	15,150	2.9	–	–	$ 29	$ 0.0	$ 255	$ 4.9
Table 24	PL-6	Effluent PL	Sunnyvale WPCP	Palo Alto AWPF	36	–	–	38,820	7.4	–	–	$ 75	$ 0.1		
Table 67	PL-44	Purified Water PL	Palo Alto AWPF	West Pipeline at Stevens Creek Blvd	36	–	–	56,600	10.7	–	–	$ 111	$ 0.1		
Table 26	PS-3	Effluent PS	Palo Alto RWQCP	Palo Alto AWPF	–	17.3	508	–	–	–	–	$ 4	$ 0.6		
Table 27	PS-4	Effluent PS	Sunnyvale WPCP	Palo Alto AWPF	–	11.5	400	–	–	–	–	$ 4	$ 0.6		
Table 69	PS-18	Purified Water PS	Palo Alto AWPF	West Pipeline	–	24.0	2,877	–	–	–	–	$ 29	$ 3.5		
–	PL Easements	Easement[d]	–	–	–	–	–	110,570	20.9	–	–	$ 4	$		
–	Source water	Purchased supply for reuse[e]	PA RWQCP and SV WPCP	–	–	–	–	–	–	23,400	23,400	$ -	$ 2.3	$ -	$ 2.4
Subtotal - Excluding ROCM														$ 635	$ 23.5
–	ROCM	ROCM strategy	–	–	–	–	–	–	–	–	–	$ -	$ -	$ -	$ -
TOTAL														**$ 635**	**$ 23.5**
NPR+ AWPFs															
Table 54	NPR+	AWPF	Palo Alto	–	–	2.25	–	–	–	–	–	$ 22	$ 1.3		
Table 54	NPR+	AWPF	Sunnyvale	–	–	1.2	–	–	–	–	–	$ 18	$ 0.7		
Table 54	NPR+	AWPF	San José	–	–	8	–	–	–	–	–	$ 83	$ 3.0		
Alternative Alignments															
Table 55	PL-36	Purified Water PL	LGRP	Rinconada WTP	30	–	–	12,400	2.3	–	–	$ 21	$ 0.02	$ 25	$ 0.1
Table 56	NPR+	NPR+ Intertie PL	Mountain View	Sunnyvale	16	–	–	18,600	3.5	–	–	$ 16	$ 0.04	$ 20	$ 0.1
Table 57	NPR+	NPR+ Intertie PL	Sunnyvale	SBWR	16	–	–	15,000	2.8			$ 23	$ 0.02	$ 25	$ 0.1
Table 58	PL-15	Purified Water PL	Moffett Field	Sunnyvale WPCP	36	–	–	17,800	3.4	–	–	$ 35	$ 0.03	$ 35	$ 0.1
Table 59	PL-16	Purified Water PL	PL connection point, near Sunnyvale WPCP	Arques (east)	36	–	–	30,300	5.7	–	–	$ 59	$ 0.05	$ 60	$ 0.1
Table 60	PL-17	Purified Water PL	PL connection point, near Sunnyvale WPCP	Arques (west)	36	–	–	11,400	2.2	–	–	$ 22	$ 0.02	$ 25	$ 0.1
Table 61	PL-18	Purified Water PL	Moffett Field	Arques (west)	36	–	–	12,300	2.3	–	–	$ 24	$ 0.02	$ 25	$ 0.1
Table 62	PL-19	Purified Water PL	Arques (west)	Arques (east)	36	–	–	12,100	2.3	–	–	$ 24	$ 0.02	$ 25	$ 0.1
Table 63	PL-20	Purified Water PL	Arques (west)	Arques (east)	48	–	–	12,100	2.3	–	–	$ 33	$ 0.02	$ 35	$ 0.1
Table 64	PL-31	Purified Water PL	PL connection point, near Sunnyvale WPCP	LGRP	48	–	–	89,600	17.0	–	–	$ 247	$ 0.2	$ 250	$ 0.2
Table 65	PL-32	Purified Water PL	Arques (west)	LGRP	48	–	–	72,500	13.7	–	–	$ 200	$ 0.1	$ 200	$ 0.2
Table 66	PL-33	Purified Water PL (Portfolio 2a alternate alignment)	Palo Alto AWPF	PL connection point, near Sunnyvale WPCP	36	–	–	38,820	7.4	–	–	$ 75	$ 0.1	$ 80	$ 0.1

a. Upper bound of yield is assumed in facility sizing for cost estimates and for the purposes of calculating source water costs. Lower bound reflects potential source water availability limitations or groundwater basin capacity. See Appendix A-2 for additional information on flow assumptions.

b. All costs reported in July 2019 dollars.

c. All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000.

d. Assumes that pipeline easement cost is $32/foot for all pipelines except Portfolios 1b, 1c, and 1d. Pipeline easements for Portfolios 1b, 1c, and 1d are assumed to cost $222/foot.

e. Assumes unit cost of source water purchased as supply for all portfolios is $100/AF. For Morgan Hill, Option 1 assumes a source water cost of $600/AF and Options 2 and 3 assume no cost for source water, due to exchange of equal volume of raw water for groundwater recharge.

f. Based on estimate prepared by for the Expedited Purified Water Program Plan, escalated to 2019 dollars.

g. Based on estimate prepared by City of Sunnyvale staff in 2016. The original estimate was rounded up to $40 million and escalated to 2019 dollars.

Portfolio 1a cost estimate details

Table 2. San José AWPF; 24 mgd for GWR (Portfolio 1a)

Focus: Cost Summary
Element: AWPF (GWR)
Capacity / Treatment: 24.5 mgd
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**130,000,000**
Contingency - Treatment Facility	25%	$	33,000,000
Construction Cost Subtotal		**$**	**163,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	25,000,000
Estimated Total Construction Cost		**$**	**196,000,000**
Owner's Reserve for Change Orders	15%	$	30,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	30,000,000
Construction Management	13%	$	26,000,000
Engineering Services During Construction	12%	$	24,000,000
Total Capital Cost		**$**	**306,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,500,000
Energy/Power	$	5,390,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,580,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	172,000,000
30-yr Lifecycle (present value, $2019)	$	75,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	15,610,000
Annual O&M Cost		$	13,580,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,500,000
Total Annual Cost		**$**	**31,690,000**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,720**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 - General Requirements	$	11,829,800	9%
Division 02 - Site Construction	$	-	0%
Division 03 - Concrete	$	7,131,400	5%
Division 04 - Masonry	$	-	0%
Division 05 - Metals	$	750,000	1%
Division 06 - Woods, Plastics, and Composites	$	-	0%
Division 07 - Thermal and Moisture Protection	$	-	0%
Division 08 - Doors and Windows	$	-	0%
Division 09 - Finishes	$	1,000,000	1%
Division 10 - Specialties	$	-	0%
Division 11 - Equipment	$	-	0%
Division 12 - Furnishings	$	-	0%
Division 13 - Special Construction	$	-	0%
Division 14 - Conveying Systems	$	-	0%
Division 15 - Mechanical	$	-	0%
Division 17 - Instrumentation	$	4,183,400	3%
Division 21 - Fire Suppression	$	-	0%
Division 22 - Plumbing	$	-	0%
Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 - Electrical	$	16,733,600	13%
Division 27 - Communications	$	-	0%
Division 28 - Electronic Safety and Security	$	-	0%
Division 31 - Earthwork	$	4,040,800	3%
Division 32 - Exterior Improvements	$	111,200	0%
Division 33 - Utilities	$	-	0%
Division 40 - Process Integration	$	16,943,700	13%
Division 41 - Material Processing and Handling Equipment	$	-	0%
Division 42 - Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	$	18,291,800	14%
Division 44 - Pollution and Waste Control Equipment	$	-	0%
Division 46 - Water and Wastewater Equipment	$	49,112,000	38%
TOTAL	**$**	**130,000,000**	

Brown AND Caldwell

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24 mgd
Location: San Jose

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements		Mobilization		10%	LS			$ 124,447,300	10% of Divisions 2-47	$ 12,444,800	
Division 31 – Earthwork		Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork		Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork		Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork		Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork		Excavation		19,448	CY		$ 11.78			$ 229,100	
Division 31 – Earthwork		Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork		Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork		Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork		Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,711	CY		$ 58.49			$ 743,500	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		7,911	SY		$ 4.63			$ 36,700	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		162	CY		$ 645		See Site Work and Concrete Tab	$ 104,700	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24 mgd
Location: San Jose

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 52.94			$ 155,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)		10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps		4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps		4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters		3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps		4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 219		245' x 345'; furnished and installed	$ 18,475,300	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24 mgd
Location: San Jose

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank	$ 3,650,000	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)		2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$49,567,400	30% of Equipment Costs	$ 14,870,300	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$14,870,300	5% of Piping Allowance	$ 743,600	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$14,870,300	5% of Piping Allowance	$ 743,600	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$14,870,300	5% of Piping Allowance	$ 743,600	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$49,567,400	30% of Equipment Costs	$ 14,870,300	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$16,870,300	25% of Electrical Costs	$ 4,217,600	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,675,400	2% of Pumping Equipment Cost	$ 33,600	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,870,300	2% of Electrical Cost	$ 337,500	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,217,600	2% of Instrumentation & Controls Cost	$ 84,400	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	

Focus:	Cost Inputs and R&R
Aspect:	AWPF (GWR)
Capacity:	24 mgd
Location:	San Jose

Date:	11/9/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 3. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1a)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-1. Effluent PL from SJ/SC RWF to San José AWPF	**Diam**	60 inch	Prepared By:	N Venugopal
		Length	2,000 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 200,000	
2 - Sitework	$ 2,600,000	
Raw Construction Subtotal	**$ 2,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 500,000	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 200,000	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							$ 2,600,000	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	Sheeting and Shoring	7%	60	2,000	LF	$ 84.00	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 3,000	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table 4. PL-2, 48-inch purified water pipeline from San José AWPF to Los Gatos Recharge Ponds (LGRP) (Portfolio 1a)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	1/30/2020
				Project Number:	437-001-105
Aspect:	PL-2. Purified water PL from San José AWPF to LGRP	**Diam**	48 inch	Prepared By:	N Venugopal
		Length	95,490 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

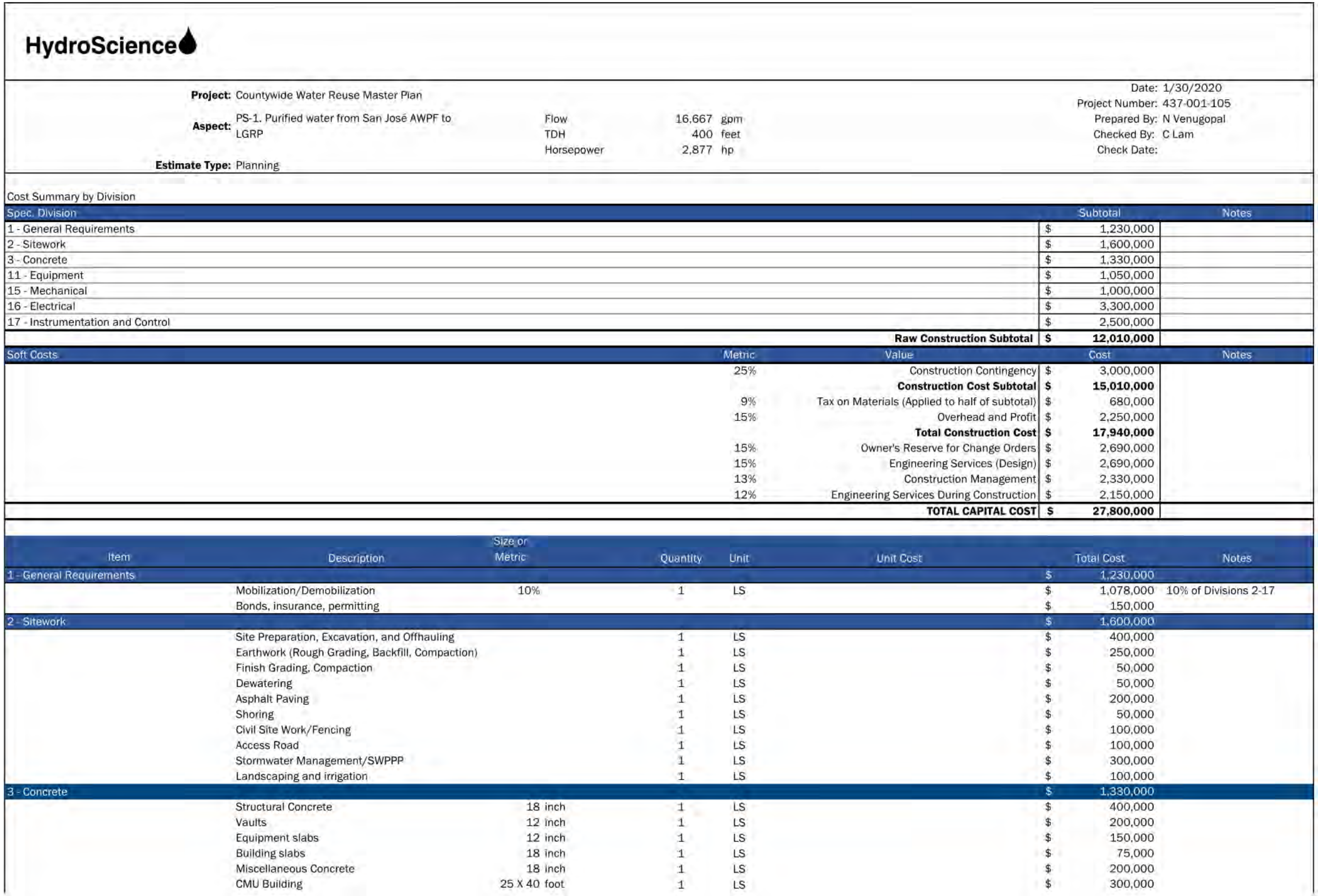
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 6,100,000	
2 - Sitework	$ 108,100,000	
Raw Construction Subtotal	**$ 114,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 28,500,000	
		Construction Cost Subtotal	**$ 142,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 21,400,000	
		Total Construction Cost	**$ 170,300,000**	
	15%	Owner's Reserve for Change Orders	$ 25,500,000	
	15%	Engineering Services (Design)	$ 25,500,000	
	13%	Construction Management	$ 22,100,000	
	12%	Engineering Services During Construction	$ 20,400,000	
		TOTAL CAPITAL COST	**$ 263,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 6,100,000	
	Traffic Control (Heavy Urban)	7%	48	91,040	LS	$ 67.20	$ 6,100,000	7% of Divisions 2-17
2 - Sitework							$ 108,100,000	
	48" Open cut pipeline		48	91,040	LF	$ 960	$ 87,400,000	
	48" Bore and Jack Pipeline & Casing		48	2,550	LF	$ 2,496	$ 6,400,000	
	48" Microtunnel Pipeline & Casing		48	1,900	LF	$ 3,360	$ 6,400,000	
	Sheeting and Shoring	7%	48	91,040	LF	$ 67.20	$ 6,100,000	
	Potholing (Heavy Urban)	2%	48	95,490	LF	$ 19.20	$ 1,800,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 156,000	
Total Operator Hours per Year		hours	163	$ -	
Annual Inspection and Pipeline Maintenance	95,490	LF	$1.63	$ 156,000	
			TOTAL ANNUAL O&M COSTS	**$ 156,000**	

Table 5. PS-1, pump station to convey San José AWPF purified water to LGRP (Portfolio 1a)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-1. Purified water from San José AWPF to LGRP
Estimate Type: Planning

Flow	16,667	gpm
TDH	400	feet
Horsepower	2,877	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	1,230,000	
	Mobilization/Demobilization	10%	1	LS		$	1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						$	1,600,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	
3 - Concrete						$	1,330,000	
	Structural Concrete	18 inch	1	LS		$	400,000	
	Vaults	12 inch	1	LS		$	200,000	
	Equipment slabs	12 inch	1	LS		$	150,000	
	Building slabs	18 inch	1	LS		$	75,000	
	Miscellaneous Concrete	18 inch	1	LS		$	200,000	
	CMU Building	25 X 40 foot	1	LS		$	300,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 1,050,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						$ 1,000,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 3,300,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						$ 2,500,000	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 157,000	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						$ 2,706,000	
	Electricity Requirement	2,877 hp	16,911,657	kWh	$0.16	$ 2,706,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,863,000**	

Table 6. LGRP site improvements (Portfolio 1a)

		2019 Estimate (Escalated to $2019)
Divisions		Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		O&M Costs
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	**$ 4,716,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							$ 579,000	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							$ 4,037,000	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Sunnyoaks Facilities									
18", PVC, 8' Cover	18	in-dia	1,180	LF	$	334	$	394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	3%		1	LS	$	11,820	$	12,000	Up to 8' of cover
Potholing			12	EA	$	3,600	$	42,000	Light Urban, $3,600 per 100 feet of pipe
30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import. 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

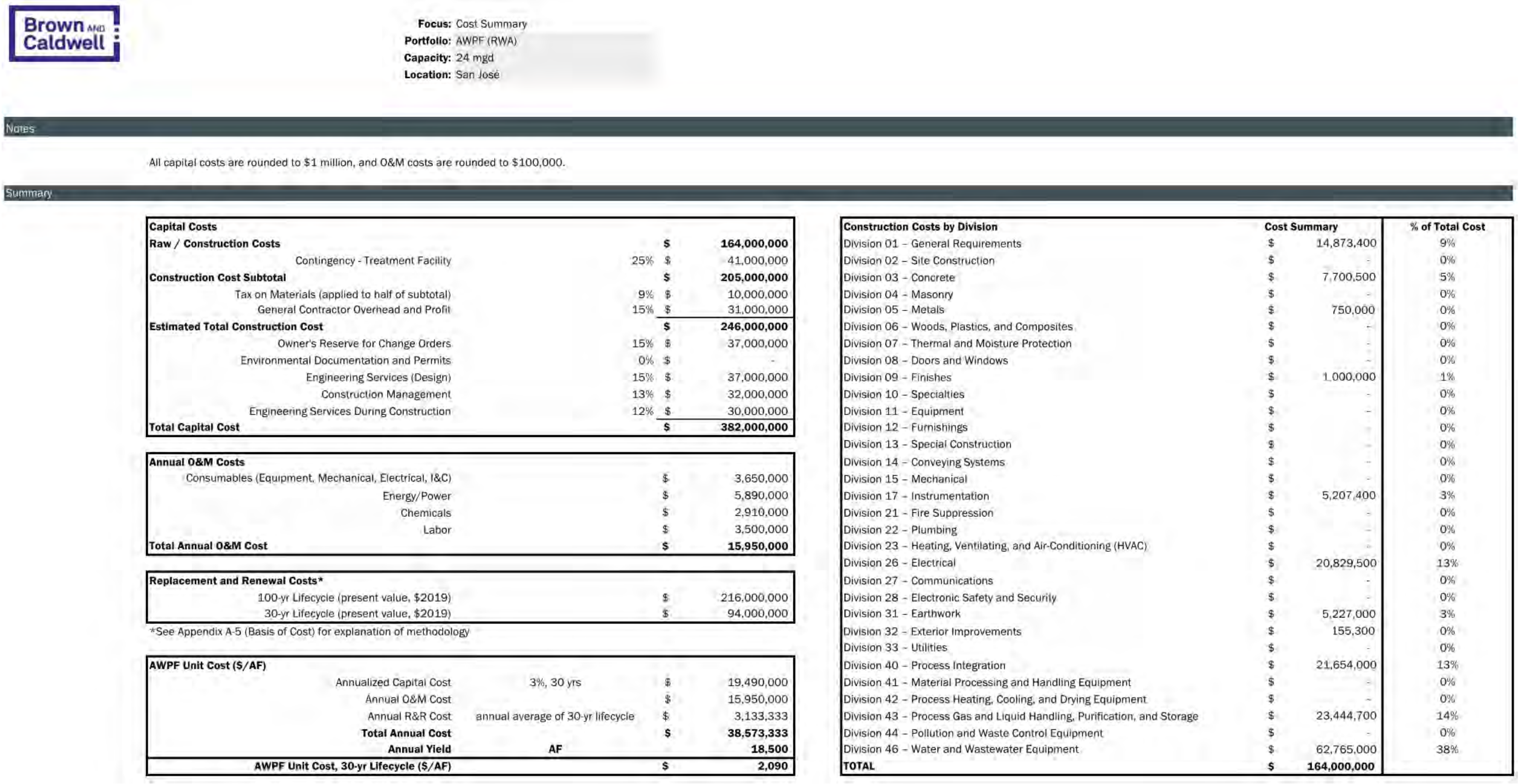
Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Kirk Ditch Facilities									
36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover
Potholing			0	EA	$	1,200	$	-	Rural, $1,200 per 100 feet of pipe
36" BFV	36	in-dia	1	EA	$	25,000	$	25,000	Engineer's estimate
30" Meter	30	in-dia	1	EA	$	60,000	$	60,000	Engineer's estimate
30" FCV	30	in-dia	1	EA	$	80,000	$	80,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			114	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			13	CY	$	1,000	$	13,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			5	CY	$	800	$	4,000	RMC, 2017 (August 2017)
Rip Rap / Apron			20	CY	$	133	$	3,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	25,000	$	25,000	regrading, etc Engineer's estimate
16 - Electrical							$	60,000	
Electrical Allowance			4	EA		$15,000	$	60,000	Engineers Estimate
17 - I&C							$	40,000	
I&C Allowance			4	EA		$10,000	$	40,000	Engineers Estimate

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Consumables				$	10,000	
Mechanical	2%		$487,000	$	10,000	2% of Valves and Meters
Labor Costs				$	315,000	
Pond Maintenance	68	AC	$4,531	$	307,000	Engineer's estimate
Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$	8,000	Engineer's estimate
		TOTAL ANNUAL O&M COSTS		**$**	**325,000**	

Portfolio 1b cost estimate details

Table 7. San José AWPF; 24 mgd for RWA (Portfolio 1b)



Focus: Cost Summary
Portfolio: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**164,000,000**
Contingency - Treatment Facility	25%	$	41,000,000
Construction Cost Subtotal		**$**	**205,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	10,000,000
General Contractor Overhead and Profit	15%	$	31,000,000
Estimated Total Construction Cost		**$**	**246,000,000**
Owner's Reserve for Change Orders	15%	$	37,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	37,000,000
Construction Management	13%	$	32,000,000
Engineering Services During Construction	12%	$	30,000,000
Total Capital Cost		**$**	**382,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	3,650,000
Energy/Power	$	5,890,000
Chemicals	$	2,910,000
Labor	$	3,500,000
Total Annual O&M Cost	**$**	**15,950,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	216,000,000
30-yr Lifecycle (present value, $2019)	$	94,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	19,490,000
Annual O&M Cost		$	15,950,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	3,133,333
Total Annual Cost		**$**	**38,573,333**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,090**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	14,873,400	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	7,700,500	5%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	0%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	5,207,400	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	20,829,500	13%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	5,227,000	3%
Division 32 – Exterior Improvements	$	155,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	21,654,000	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	23,444,700	14%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	62,765,000	38%
TOTAL	**$**	**164,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$148,733,400	10% of Divisions 2-47	$ 14,873,400	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		19,682	CY		$ 11.78			$ 231,900	
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		7,611	SY		$ 4.63			$ 35,300	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		213	CY		$ 645		See Site Work and Concrete Tab	$ 137,600	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		594	CY		$ 1,090		See Site Work and Concrete Tab	$ 647,300	Ozone and LOX Area
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	BAC Filter Slab		373	CY		$ 645		See Site Work and Concrete Tab	$ 240,800	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 - Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 - Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 - Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 - Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 - Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 - Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station
Division 03 - Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 - Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300	
Division 05 - Metals	Metals	Misc. Metals Allowance		1	LS			$750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 - Finishes	Finishes	Coating Allowance		1	LS			$1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 - Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco	$ 7,455,900	
Division 46 - Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ 5,741,700	
Division 46 - Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	EA	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 - Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 - Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 - Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375.00		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank	$ 3,650,000	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks

Brown AND Caldwell

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 24 mgd
Location: San José

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$62,765,000	30% of Equipment Costs	$ 18,829,500	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 26 - Electrical	Electrical	Electrical Allowance		30%	% of			$62,765,000	30% of Equipment Costs	$ 18,829,500	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$20,829,500	25% of Electrical Costs	$ 5,207,400	
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ 1,046,200	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,675,400	2% of Pumping Equipment Cost	$ 33,600	
O&M	Consumables	Electrical Consumables		2%	% of			$ 20,829,500	2% of Electrical Cost	$ 416,600	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 5,207,400	2% of Instrumentation & Controls Cost	$ 104,200	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ 290,800	
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ 14,900	
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ 21,800	
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ 30,500	
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ 11,900	
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ 4,000	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ 21,100	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	

Focus:	Cost Inputs and R&R
Aspect:	AWPF (RWA)
Capacity:	24 mgd
Location:	San José

Date:	11/9/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Engineer:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		8,320	hours/yr		$ 163.20			$ 1,357,900	Assumes three plant operators 40 hours per week for 52 weeks in a year (4 FTE)
O&M	Labor	Sr Mechanics		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 8. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolio 1b)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-1. Effluent PL from SJ/SC RWF to San José AWPF	**Diam**	60 inch	Prepared By:	N Venugopal
		Length	2,000 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

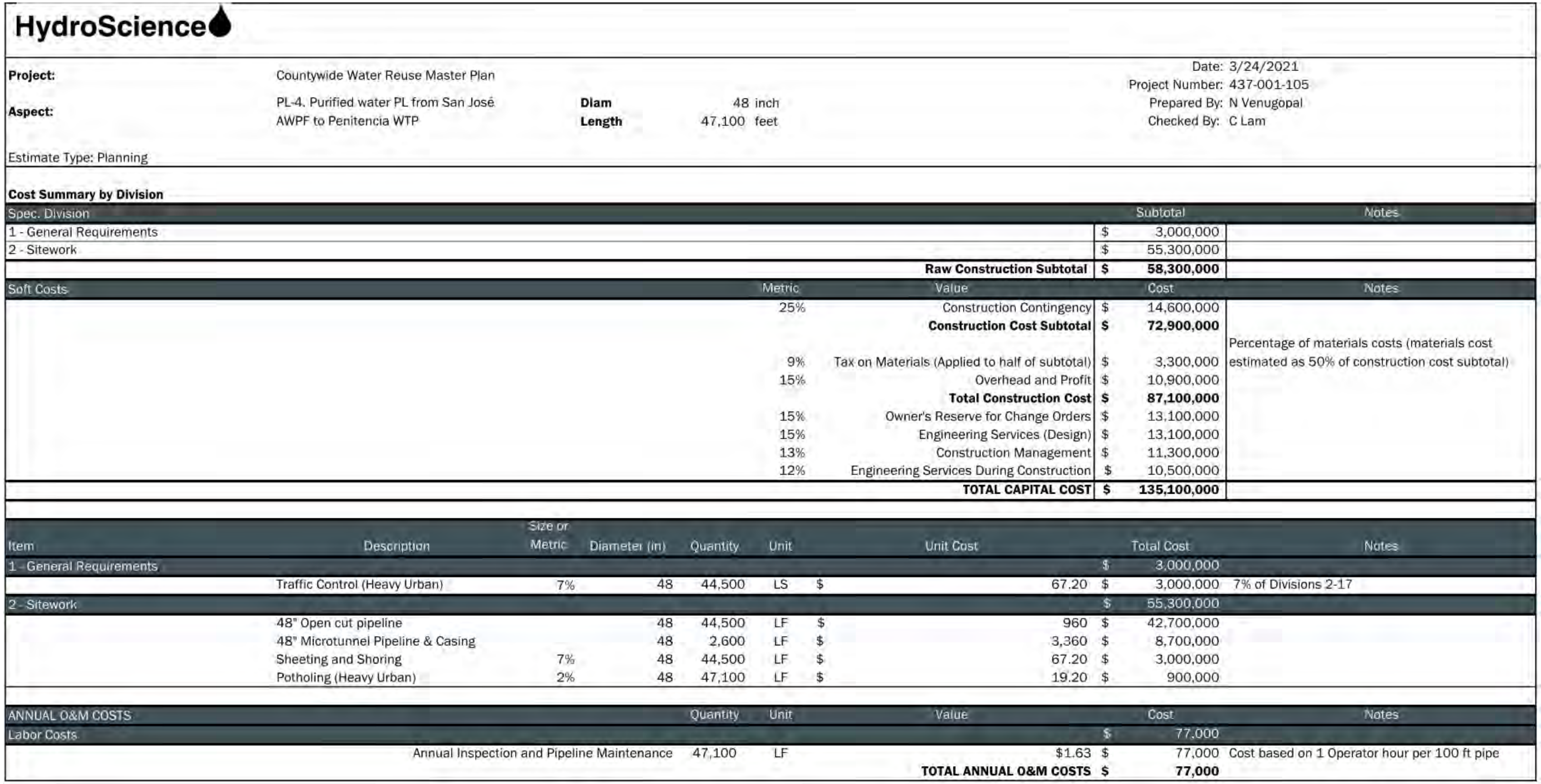
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 200,000	
2 - Sitework	$ 2,600,000	
Raw Construction Subtotal	**$ 2,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 500,000	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 200,000	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							$ 2,600,000	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	Sheeting and Shoring	7%	60	2,000	LF	$ 84.00	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 3,000	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table 9. PL-4, 48-inch purified water pipeline from San José AWPF to Penitencia WTP (Portfolio 1b)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-4. Purified water PL from San José AWPF to Penitencia WTP	**Diam**	48 inch	Prepared By:	N Venugopal
		Length	47,100 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	3,000,000	
2 - Sitework	$	55,300,000	
Raw Construction Subtotal	**$**	**58,300,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	14,600,000	
		Construction Cost Subtotal	**$**	**72,900,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	3,300,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	10,900,000	
		Total Construction Cost	**$**	**87,100,000**	
	15%	Owner's Reserve for Change Orders	$	13,100,000	
	15%	Engineering Services (Design)	$	13,100,000	
	13%	Construction Management	$	11,300,000	
	12%	Engineering Services During Construction	$	10,500,000	
		TOTAL CAPITAL COST	**$**	**135,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	3,000,000	
	Traffic Control (Heavy Urban)	7%	48	44,500	LS	$	67.20	$	3,000,000	7% of Divisions 2-17
2 - Sitework								$	55,300,000	
	48" Open cut pipeline		48	44,500	LF	$	960	$	42,700,000	
	48" Microtunnel Pipeline & Casing		48	2,600	LF	$	3,360	$	8,700,000	
	Sheeting and Shoring	7%	48	44,500	LF	$	67.20	$	3,000,000	
	Potholing (Heavy Urban)	2%	48	47,100	LF	$	19.20	$	900,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	77,000	
Annual Inspection and Pipeline Maintenance	47,100	LF	$1.63	$	77,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**77,000**	

Table 10. PS-2, pump station to convey San José AWPF purified water to Penitencia WTP (Portfolio 1b)

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-2. Purified water from San José AWPF to Penitencia WTP
Estimate Type: Planning

Flow 16,667 gpm
TDH 550 feet
Horsepower 3,977 hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,800,000	
2 - Sitework	$ 1,900,000	
3 - Concrete	$ 1,930,000	
11 - Equipment	$ 2,000,000	
15 - Mechanical	$ 1,050,000	
16 - Electrical	$ 4,200,000	
17 - Instrumentation and Control	$ 2,900,000	
Raw Construction Subtotal	**$ 15,780,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,950,000	
		Construction Cost Subtotal	**$ 19,730,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 890,000	
	15%	Overhead and Profit	$ 2,960,000	
		Total Construction Cost	**$ 23,580,000**	
	15%	Owner's Reserve for Change Orders	$ 3,540,000	
	15%	Engineering Services (Design)	$ 3,540,000	
	13%	Construction Management	$ 3,070,000	
	12%	Engineering Services During Construction	$ 2,830,000	
		TOTAL CAPITAL COST	**$ 36,560,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 1,800,000	
	Mobilization/Demobilization	10%	1	LS		$ 1,398,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 400,000	
2 - Sitework						$ 1,900,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 500,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 350,000	
	Finish Grading, Compaction		1	LS		$ 75,000	
	Dewatering		1	LS		$ 75,000	
	Asphalt Paving		1	LS		$ 200,000	
	Shoring		1	LS		$ 100,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 300,000	
	Landscaping and irrigation		1	LS		$ 100,000	
3 - Concrete						$ 1,930,000	
	Structural Concrete	18 inch	1	LS		$ 520,000	
	Vaults	12 inch	1	LS		$ 260,000	
	Equipment slabs	12 inch	1	LS		$ 200,000	
	Building slabs	18 inch	1	LS		$ 150,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 300,000	
	CMU Building	40 X 50 foot	1	LS		$ 500,000	

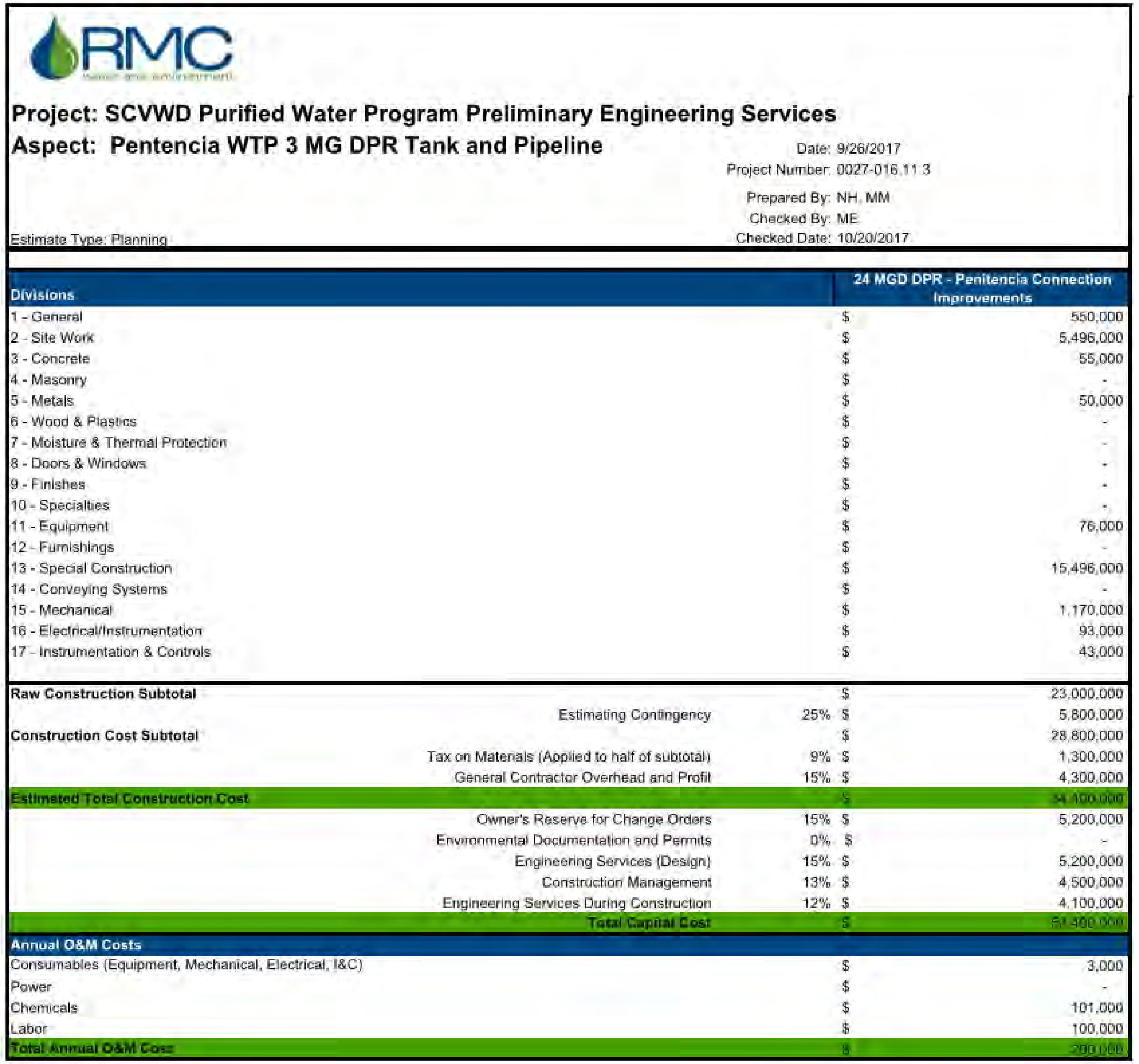
Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
11 - Equipment							$	2,000,000	
	Vertical turbine pumps, cans, housing			1	LS		$	1,500,000	
	Surge Tank			1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)			1	LS		$	400,000	
15 - Mechanical							$	1,050,000	
	Water/Sewer/Storm Utility improvements			1	LS		$	250,000	
	Yard piping, Valves, and Appurtenances			1	LS		$	800,000	
16 - Electrical							$	4,200,000	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$	3,000,000	
	Standby generator			1	LS		$	1,200,000	
17 - I&C							$	2,900,000	
	I&C/SCADA/Programming Allowance						$	2,900,000	
ANNUAL O&M COSTS				Quantity	Unit	Value		Cost	Notes
Consumables							$	203,000	
	Equipment			2%		$2,000,000	$	40,000	2% of Division 11
	Mechanical			2%		$1,050,000	$	21,000	2% of Division 15
	Electrical			2%		$4,200,000	$	84,000	2% of Division 16
	Instrumentation			2%		$2,900,000	$	58,000	2% of Division 17
Power Costs							$	3,740,000	
	Electricity Requirement	3,977	hp	23,377,706	kWh	$0.16	$	3,740,000	
						TOTAL ANNUAL O&M COSTS	**$**	**3,943,000**	

Table 11. Penitencia WTP site improvements (Portfolio 1b)

2019 Estimate (Escalated to $2019)

Divisions			Penitencia Improvements WTP 3 MG DPR Tank and Pipeline ($2019)
1 - General		$	565,000
2 - Site Work		$	5,647,000
3 - Concrete		$	57,000
5 - Metals		$	51,000
11 - Equipment		$	78,000
13 - Special Construction		$	15,922,000
15 - Mechanical		$	1,202,000
16 - Electrical/Instrumentation		$	96,000
17 - Instrumentation & Controls		$	44,000
Subtotal[1]		**$**	**23,600,000**
Construction Contingency	25%	$	5,900,000
Construction Cost Subtotal		**$**	**29,592,000**
Tax on Materials (Applied to half of subtotal)	9%	$	1,300,000
Overhead and Profit	15%	$	4,400,000
Total Construction Cost		**$**	**35,300,000**
Owner's Reserve for Change Orders	15%	$	5,300,000
Engineering Services (Design)	15%	$	5,300,000
Construction Management	13%	$	4,600,000
Engineering Services During Construction	12%	$	4,200,000
Total Capital Cost		**$**	**54,700,000**
O&M Costs		O&M Costs	
Consumables (Equipment, Mechanical, Electrical, I&C)		$	3,000
Chemicals		$	104,000
Labor		$	103,000
Total O&M		$	210,000

1. Subtotal rounded to nearest hundred thousand



RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services
Aspect: Pentencia WTP 3 MG DPR Tank and Pipeline

Date: 9/26/2017
Project Number: 0027-016.11.3
Prepared By: NH, MM
Checked By: ME
Checked Date: 10/20/2017

Estimate Type: Planning

Divisions			**24 MGD DPR - Penitencia Connection Improvements**
1 - General		$	550,000
2 - Site Work		$	5,496,000
3 - Concrete		$	55,000
4 - Masonry		$	-
5 - Metals		$	50,000
6 - Wood & Plastics		$	-
7 - Moisture & Thermal Protection		$	-
8 - Doors & Windows		$	-
9 - Finishes		$	-
10 - Specialties		$	-
11 - Equipment		$	76,000
12 - Furnishings		$	-
13 - Special Construction		$	15,496,000
14 - Conveying Systems		$	-
15 - Mechanical		$	1,170,000
16 - Electrical/Instrumentation		$	93,000
17 - Instrumentation & Controls		$	43,000
Raw Construction Subtotal		$	23,000,000
Estimating Contingency	25%	$	5,800,000
Construction Cost Subtotal		$	28,800,000
Tax on Materials (Applied to half of subtotal)	9%	$	1,300,000
General Contractor Overhead and Profit	15%	$	4,300,000
Estimated Total Construction Cost		$	34,100,000
Owner's Reserve for Change Orders	15%	$	5,200,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	5,200,000
Construction Management	13%	$	4,500,000
Engineering Services During Construction	12%	$	4,100,000
Total Capital Cost		$	53,100,000
Annual O&M Costs			
Consumables (Equipment, Mechanical, Electrical, I&C)		$	3,000
Power		$	-
Chemicals		$	101,000
Labor		$	100,000
Total Annual O&M Cost		$	200,000

Project: SCVWD Purified Water Program
Preliminary Engineering Services

Aspect: Penitencia WTP 3 MG DPR Tank and Pipeline

Estimate Type: Planning

Date: 26-Sep-17
Project Number: 0027-016.11.3
Prepared By: NH, MM
Checked By: ME
Check Date: 20-Oct-17

Process Cost Summary by Division

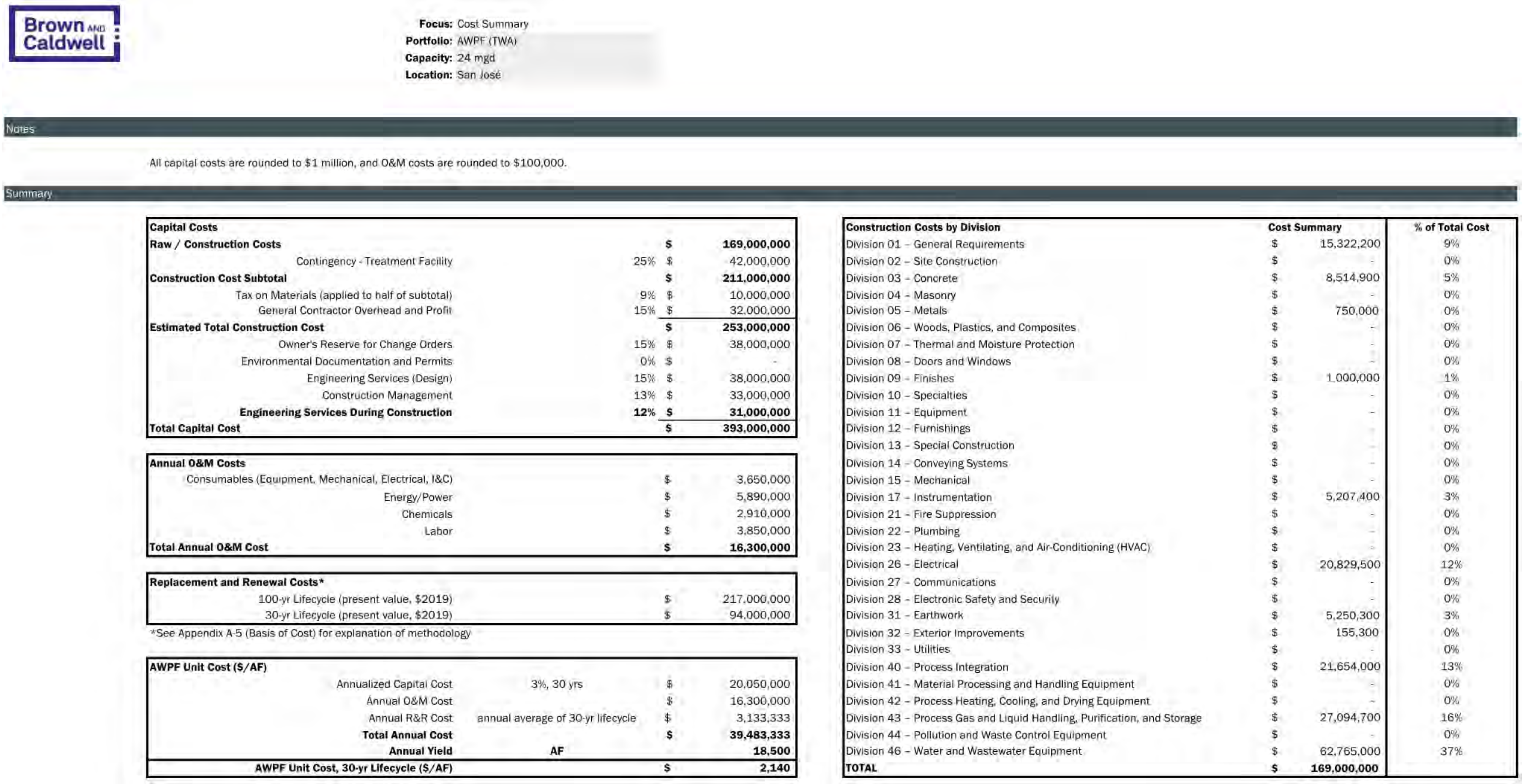
Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 550,000	
2 - Sitework	$ 5,496,000	
3 - Concrete	$ 55,000	
5 - Metals	$ 50,000	
11 - Equipment	$ 76,000	
13 - Special Construction	$ 15,495,000	
15 - Mechanical	$ 1,169,000	
16 - Electrical	$ 93,000	
17 - Instrumentation and Control	$ 43,000	
Subtotal	**$ 23,027,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 550,000	
	Mobilization	10%		1	LS	$549,600	$ 550,000	10% of Divisions 2-17
2 - Sitework							$ 5,496,000	
	Site Clear and Grub			4	Acre	$9,156	$ 35,000	
	Strip Topsoil			18,457	SY	$0.77	$ 15,000	
	Compaction			166,110	SF	$1.14	$ 190,000	
	Grading			6,152	CY	$1.52	$ 10,000	
	Excavation			31,779	CY	$15	$ 487,000	
	Offhaul Allowance			31,779	CY	$12	$ 385,000	
	Aggregate Base			1,667	CY	$59	$ 99,000	
	Asphalt			10,000	SF	$3	$ 27,000	
	Chain Linke Fence Arround Penitencia WTP			2,946	LF	$67	$ 199,000	
	Lighting and Security Allowance			1	LS	$20,000	$ 20,000	
	Conveyance Pipelines							
	66-inch blended DPR Water, MLCSP, 8' Cover	66	in-dia	1,800	LF	$958	$ 1,726,000	
	Sheeting and Shoring (Open Cut)	3%		1	LS	$51,780	$ 52,000	
	Potholing			18	EA	$1,200	$ 22,000	
	66-inch Blended and Penitencia Force Main (Central Pipeline) Connection			1	LS	$100,000	$ 100,000	
	48-inch DPR Pipeline, MLCSP, 8' Cover to 3 MG Tank	48	in-dia	2,108	LF	$632	$ 1,333,000	
	Sheeting and Shoring (Open Cut)	3%		1	LS	$39,990	$ 40,000	
	Potholing			21	EA	$1,200	$ 25,000	
	48-inch DPR Pipeline, MLCSP, 8' Cover to 3 MG Tank	48	in-dia	566	LF	$632	$ 358,000	Rs Means
	Sheeting and Shoring (Open Cut)	3%		1	LS	$10,740	$ 11,000	Engineer's estimate
	Potholing			6	EA	$1,200	$ 7,000	Vendor estimate
	36-inch DPR Bypass Pipeline, MLCSP, 8' Cover	42	in-dia	520	LF	$464	$ 242,000	RS Means
	Sheeting and Shoring (Open Cut)	3%		1	LS	$7,260	$ 7,000	RS Means
	Potholing			5	EA	$1,200	$ 6,000	RS Means
	36-inch DPR Bypass Pipeline and 42-inch existing bypass connection			1	LS	$100,000	$ 100,000	
3 - Concrete							$ 55,000	
	Chemical Storage							
	Chemial Storage Slab			56	CY	$800	$ 44,000	
	Chemical Storage Area Walls			11	CY	$1,000	$ 11,000	
5 - Metals							$ 50,000	
	Misc. Metals Allowance			1	LS	$50,000	$ 50,000	

11 - Equipment						$ 76,000	
Chemical Dosing							
Sodium Bisulfite Metering Pumps			2	EA	$38,000	$ 76,000	Skid mounted pump; incl. valves and appurtenances
13 - Special Construction						$ 15,495,498	
3 MG storage tank							
Purified Water Storage Tank			1	LS	$5,391,000	$ 5,400,000	
Foundation Stabilization			1	EA	$10,000,000	$ 10,000,000	
66" Fitting on Existing Tank			1	EA	$50,000	$ 50,000	
Chemical Storage Canopy							
Chemical Storage Area Canopy			325	SF	$97	$ 31,498	
Chemical Tanks							
Sodium Bisulfite Tank (HDXLPE, Vert.)	3,000	gallons	2	EA	$7,000	$ 14,000	
15 - Mechanical						$ 1,169,050	
Piping Allowance	10%		1	LS	$9,000	$ 9,000	
Valve Allowance	10%		1	LS	$9,000	$ 9,000	
Pipe Supports for supporting daylighted 66" blended pipeline before connection with the PFM			2	EA	$150,000	$ 300,000	
66" BFV	66		1	EA	$60,000	$ 60,000	
36" FCV	36		1	EA	$113,050	$ 113,050	
48" BFV	48		3	EA	$25,979	$ 78,000	
Flow Control Valve Vault	48		1	EA	$100,000	$ 100,000	
Magnetic Flow Meter and Vault	48		1	EA	$200,000	$ 200,000	
Magnetic Flow Meter and Vault	66		1	EA	$300,000	$ 300,000	
16 - Electrical						$ 93,000	
Electrical Allowance for 3 MG Tank			1	LS	$20,000	$ 20,000	
Electrical Allowance for Chemical Storage	30%		1	LS	$23,000	$ 23,000	
Feeder Electrical Line to Tank			1	LS	$50,000	$ 50,000	
17 - I&C						$ 43,000	
I&C Allowance for the 3 MG Tank			1	EA	$20,000	$ 20,000	
I&C Allowance for Chemical Storage	30%		1	LS	$23,000	$ 23,000	

Portfolios 1c and 1d cost estimate details

Table 12. San José AWPF; 24 mgd for TWA (Portfolios 1c and 1d)



Focus: Cost Summary
Portfolio: AWPF (TWA)
Capacity: 24 mgd
Location: San José

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**169,000,000**
Contingency - Treatment Facility	25%	$	42,000,000
Construction Cost Subtotal		**$**	**211,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	10,000,000
General Contractor Overhead and Profit	15%	$	32,000,000
Estimated Total Construction Cost		**$**	**253,000,000**
Owner's Reserve for Change Orders	15%	$	38,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	38,000,000
Construction Management	13%	$	33,000,000
Engineering Services During Construction	**12%**	**$**	**31,000,000**
Total Capital Cost		**$**	**393,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	3,650,000
Energy/Power	$	5,890,000
Chemicals	$	2,910,000
Labor	$	3,850,000
Total Annual O&M Cost	**$**	**16,300,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	217,000,000
30-yr Lifecycle (present value, $2019)	$	94,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	20,050,000
Annual O&M Cost		$	16,300,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	3,133,333
Total Annual Cost		**$**	**39,483,333**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,140**

Construction Costs by Division		**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$	15,322,200	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	8,514,900	5%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	0%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	5,207,400	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	20,829,500	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	5,250,300	3%
Division 32 – Exterior Improvements	$	155,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	21,654,000	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	27,094,700	16%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	62,765,000	37%
TOTAL	**$**	**169,000,000**	

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$153,221,100	10% of Divisions 2-47	$ 15,322,200	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200	
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		22,423	CY		$ 11.78			$ 264,200	
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800	
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		5,666	SY		$ 4.63			$ 26,300	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ 206,400	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ 627,900	Ozone and LOX Area
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ 275,200	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ 346,900	Treatment Equipment

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ 253,600	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ 130,100	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 - Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 - Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building
Division 03 - Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station
Division 03 - Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station
Division 03 - Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 - Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ 7,455,900	
Division 46 - Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ 5,741,700	
Division 46 - Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	EA	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 - Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 - Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 - Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 - Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 46 - Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 - Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 - Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375.00		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	2	EA	$ 3,650,000			From DN Tanks cost proposal, need two 4 MG tanks	$ 7,300,000	Prestressed Concrete Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 - Process Integration	Mechanical	Piping allowance		30%	% of			$62,765,000	30% of Equipment Costs	$ 18,829,500	

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Division 40 - Process Integration	Mechanical	Valve allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 40 - Process Integration	Mechanical	Fitting allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 40 - Process Integration	Mechanical	Supports allowance		5%	% of			$18,829,500	5% of Piping Allowance	$ 941,500	
Division 26 - Electrical	Electrical	Electrical Allowance		30%	% of			$62,765,000	30% of Equipment Costs	$ 18,829,500	
Division 17 - Instrumentation	I&C	I&C Allowance		25%	% of			$20,829,500	25% of Electrical Costs	$ 5,207,400	
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ 1,046,200	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,675,400	2% of Pumping Equipment Cost	$ 33,600	
O&M	Consumables	Electrical Consumables		2%	% of			$ 20,829,500	2% of Electrical Cost	$ 416,600	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 5,207,400	2% of Instrumentation & Controls Cost	$ 104,200	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ 290,800	
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ 14,900	
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ 21,800	
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ 30,500	
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ 11,900	
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ 4,000	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,764,439	kWh		$ 0.10			$ 182,600	
O&M	Power	Waste Equalization Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ 21,100	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	

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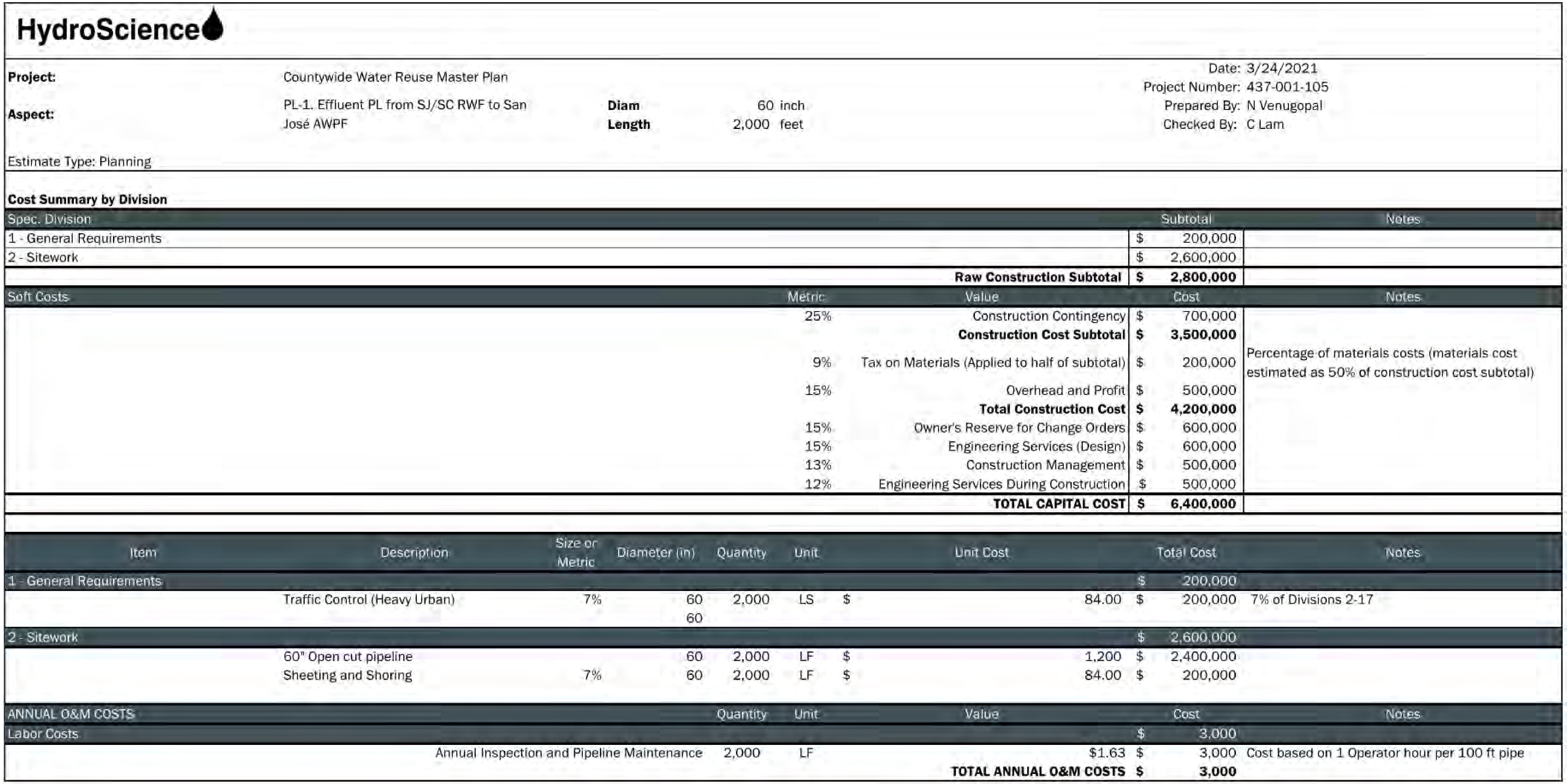
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		8,320	hours/yr		$ 163.20			$ 1,357,900	Assumes three plant operators 40 hours per week for 52 weeks in a year (4 FTE)
O&M	Labor	Sr Mechanics		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Control Tech II		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two control tech 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 13. PL-1, 60-inch effluent pipeline from SJ/SC RWF to San José AWPF (Portfolios 1c and 1d)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-1. Effluent PL from SJ/SC RWF to San José AWPF

Diam 60 inch

Length 2,000 feet

Date: 3/24/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 200,000	
2 - Sitework		$ 2,600,000	
	Raw Construction Subtotal	**$ 2,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 500,000	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 200,000	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	$ 200,000	7% of Divisions 2-17
			60					
2 - Sitework							$ 2,600,000	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	Sheeting and Shoring	7%	60	2,000	LF	$ 84.00	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 3,000	
	Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table 14. PL-40, 36-inch purified water pipeline from San José AWPF to Gibraltar Reservoir at the Milpitas Pipeline North Terminus (Portfolio 1c)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-40: SJ AWPF to Gibraltar (TWA)

Estimate Type: Planning

Diam 36 inch
Length 20,800 feet

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 900,000	
2 - Sitework		$ 16,700,000	
	Raw Construction Subtotal	**$ 18,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 4,500,000	
		Construction Cost Subtotal	**$ 22,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,000,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 3,400,000	
		Total Construction Cost	**$ 26,900,000**	
	15%	Owner's Reserve for Change Orders	$ 4,000,000	
	15%	Engineering Services (Design)	$ 4,000,000	
	13%	Construction Management	$ 3,500,000	
	12%	Engineering Services During Construction	$ 3,200,000	
		Total Capital Cost	**$ 42,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 900,000	
	Traffic Control (Heavy Urban)	7%	36	18,800	LS	$ 50.40	$ 900,000	7% of Divisions 2-17
2 - Sitework							$ 16,700,000	
	36" Open cut pipeline		36	18,800	LF	$ 720	$ 13,500,000	
	36" HDD Pipeline		36	2,000	LF	$ 1,008	$ 2,000,000	
	Sheeting and Shoring	7%	36	18,800	LF	$ 50.40	$ 900,000	
	Potholing (Heavy Urban)	2%	36	20,800	LF	$ 14.40	$ 300,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 34,000	
	Annual Inspection and Pipeline Maintenance	20,800	LF	$1.63	$ 34,000	
				TOTAL ANNUAL O&M COSTS	**$ 34,000**	

Table 15. PL-41, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolio 1c)

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PL-41: SJ AWPF to SJ Muni and Santa Clara (N of Hwy 101) (TWA) — Diam 24 inch; Length 24,700 feet
Estimate Type: Planning

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 800,000	
2 - Sitework		$ 13,300,000	
	Raw Construction Subtotal	**$ 14,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,500,000	
		Construction Cost Subtotal	**$ 17,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,600,000	
		Total Construction Cost	**$ 20,900,000**	
	15%	Owner's Reserve for Change Orders	$ 3,100,000	
	15%	Engineering Services (Design)	$ 3,100,000	
	13%	Construction Management	$ 2,720,000	
	12%	Engineering Services During Construction	$ 2,500,000	
		Total Capital Cost	**$ 32,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 800,000	
	Traffic Control (Heavy Urban)	7%	24	23,550	LS	$ 33.60	$ 800,000	7% of Divisions 2-17
2 - Sitework							$ 13,300,000	
	24" Open cut pipeline		24	23,550	LF	$ 480	$ 11,300,000	
	24" HDD Pipeline		24	850	LF	$ 672	$ 600,000	
	Sheeting and Shoring	7%	24	23,550	LF	$ 33.60	$ 800,000	
	Potholing (Heavy Urban)	2%	24	24,700	LF	$ 9.60	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 40,000	
Annual Inspection and Pipeline Maintenance	24,700	LF	$1.63	$ 40,000	
			TOTAL ANNUAL O&M COSTS	**$ 40,000**	

Brown AND Caldwell

Table 16. PS-14, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-40 and Milpitas Pipeline (Portfolios 1c)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-14. Purified water from San José AWPF to PWTP mod valve through MPL (TWA)

Flow	16,667	gpm
TDH	350	feet
Horsepower	2,500	hp

Estimate Type: Planning

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,670,000	
2 - Sitework	$	1,900,000	
3 - Concrete	$	1,930,000	
11 - Equipment	$	2,000,000	
15 - Mechanical	$	1,050,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**14,350,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,590,000	
		Construction Cost Subtotal	**$**	**17,940,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	810,000	
	15%	Overhead and Profit	$	2,690,000	
		Total Construction Cost	**$**	**21,440,000**	
	15%	Owner's Reserve for Change Orders	$	3,220,000	
	15%	Engineering Services (Design)	$	3,220,000	
	13%	Construction Management	$	2,790,000	
	12%	Engineering Services During Construction	$	2,570,000	
		TOTAL CAPITAL COST	**$**	**33,240,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	1,670,000	
	Mobilization/Demobilization	10%	1	LS		$	1,268,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	400,000	
2 - Sitework						$	1,900,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	500,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	350,000	
	Finish Grading, Compaction		1	LS		$	75,000	
	Dewatering		1	LS		$	75,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	100,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	
3 - Concrete						$	1,930,000	
	Structural Concrete	18 inch	1	LS		$	520,000	
	Vaults	12 inch	1	LS		$	260,000	
	Equipment slabs	12 inch	1	LS		$	200,000	
	Building slabs	18 inch	1	LS		$	150,000	
	Miscellaneous Concrete	18 inch	1	LS		$	300,000	
	CMU Building	40 X 50 foot	1	LS		$	500,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 2,000,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 1,500,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 400,000	
15 - Mechanical						$ 1,050,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 250,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 3,300,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						$ 2,500,000	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 177,000	
	Equipment		2%		$2,000,000	$ 40,000	2% of Division 11
	Mechanical		2%		$1,050,000	$ 21,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						$ 2,351,000	
	Electricity Requirement	2,500 hp	14,695,566	kWh	$0.16	$ 2,351,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,528,000**	

Table 17. PS-15, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolios 1c)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/13/2020
				Project Number:	437-001-105
Aspect:	PS-15. Purified water from San José AWPF to Santa Clara (N of Hwy 101) (TWA)	Flow	8,333 gpm	Prepared By:	C Lam
		TDH	250 feet	Checked By:	C Lam
		Horsepower	890 hp	Check Date:	
Estimate Type:	Planning				

Cost Summary by Division

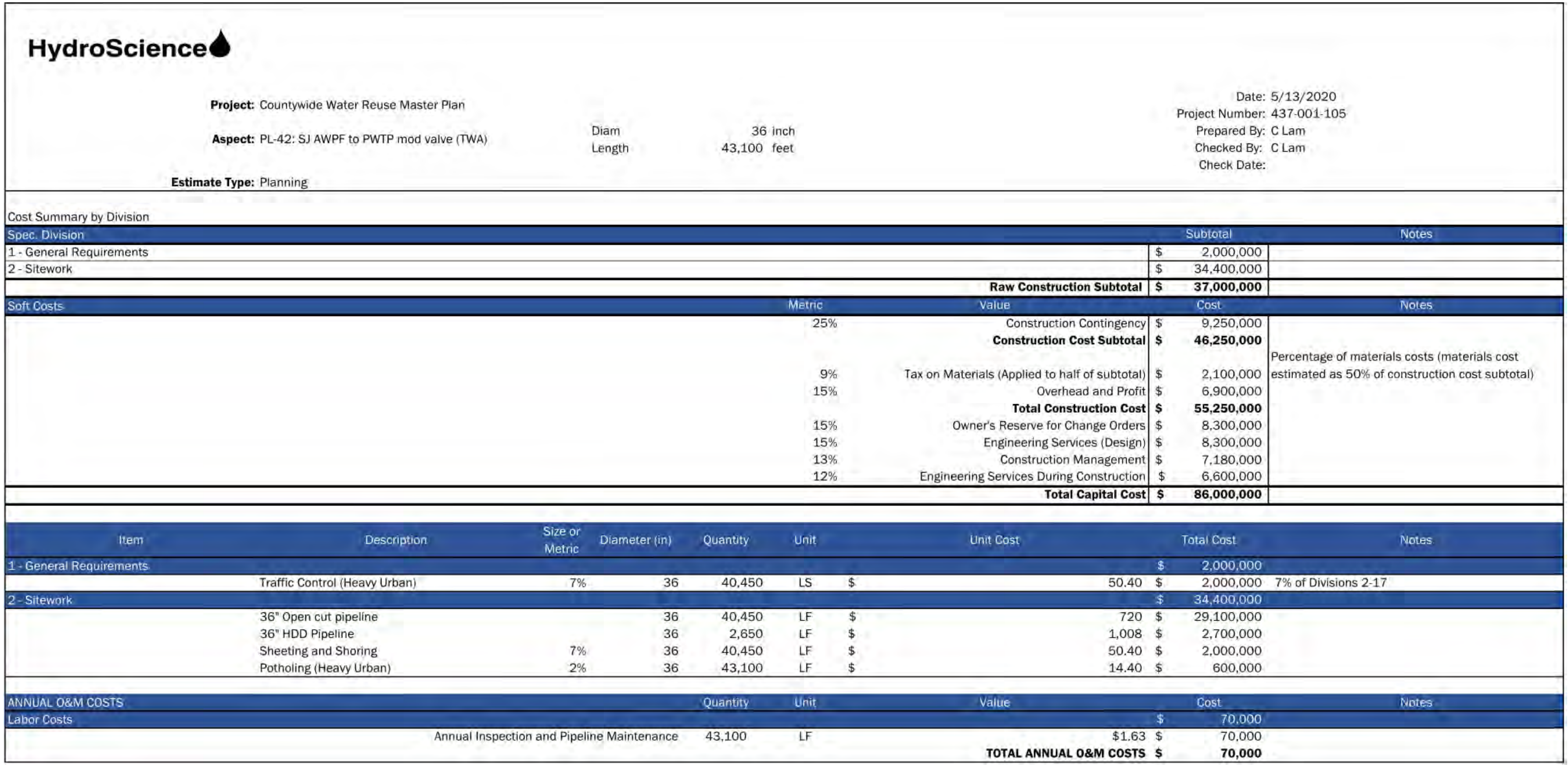
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 750,000	
2 - Sitework	$ 1,050,000	
3 - Concrete	$ 780,000	
11 - Equipment	$ 650,000	
15 - Mechanical	$ 540,000	
16 - Electrical	$ 1,750,000	
17 - Instrumentation and Control	$ 1,250,000	
Raw Construction Subtotal	**$ 6,770,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,690,000	
		Construction Cost Subtotal	**$ 8,460,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 380,000	
	15%	Overhead and Profit	$ 1,270,000	
		Total Construction Cost	**$ 10,110,000**	
	15%	Owner's Reserve for Change Orders	$ 1,520,000	
	15%	Engineering Services (Design)	$ 1,520,000	
	13%	Construction Management	$ 1,310,000	
	12%	Engineering Services During Construction	$ 1,210,000	
		TOTAL CAPITAL COST	**$ 15,670,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 750,000	
	Mobilization/Demobilization	10%	1	LS		$ 602,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						$ 1,050,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 200,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 100,000	
	Landscaping and irrigation		1	LS		$ 50,000	
3 - Concrete						$ 780,000	
	Structural Concrete	18 inch	1	LS		$ 300,000	
	Vaults	12 inch	1	LS		$ 100,000	
	Equipment slabs	12 inch	1	LS		$ 50,000	
	Building slabs	18 inch	1	LS		$ 50,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 75,000	
	CMU Building	40 X 50 foot	1	LS		$ 200,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 650,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 450,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 125,000	
15 - Mechanical						$ 540,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 140,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 400,000	
16 - Electrical						$ 1,750,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,250,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						$ 1,250,000	
	I&C/SCADA/Programming Allowance					$ 1,250,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 83,800	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$540,000	$ 10,800	2% of Division 15
	Electrical		2%		$1,750,000	$ 35,000	2% of Division 16
	Instrumentation		2%		$1,250,000	$ 25,000	2% of Division 17
Power Costs						$ 837,000	
	Electricity Requirement	890 hp	5,233,464	kWh	$0.16	$ 837,000	
					TOTAL ANNUAL O&M COSTS	**$ 920,800**	

Table 18. PL-42, 36-inch purified water pipeline from San José AWPF to modulating valve vault at Penitencia WTP (Portfolio 1d)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-42: SJ AWPF to PWTP mod valve (TWA)

Diam 36 inch
Length 43,100 feet

Estimate Type: Planning

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

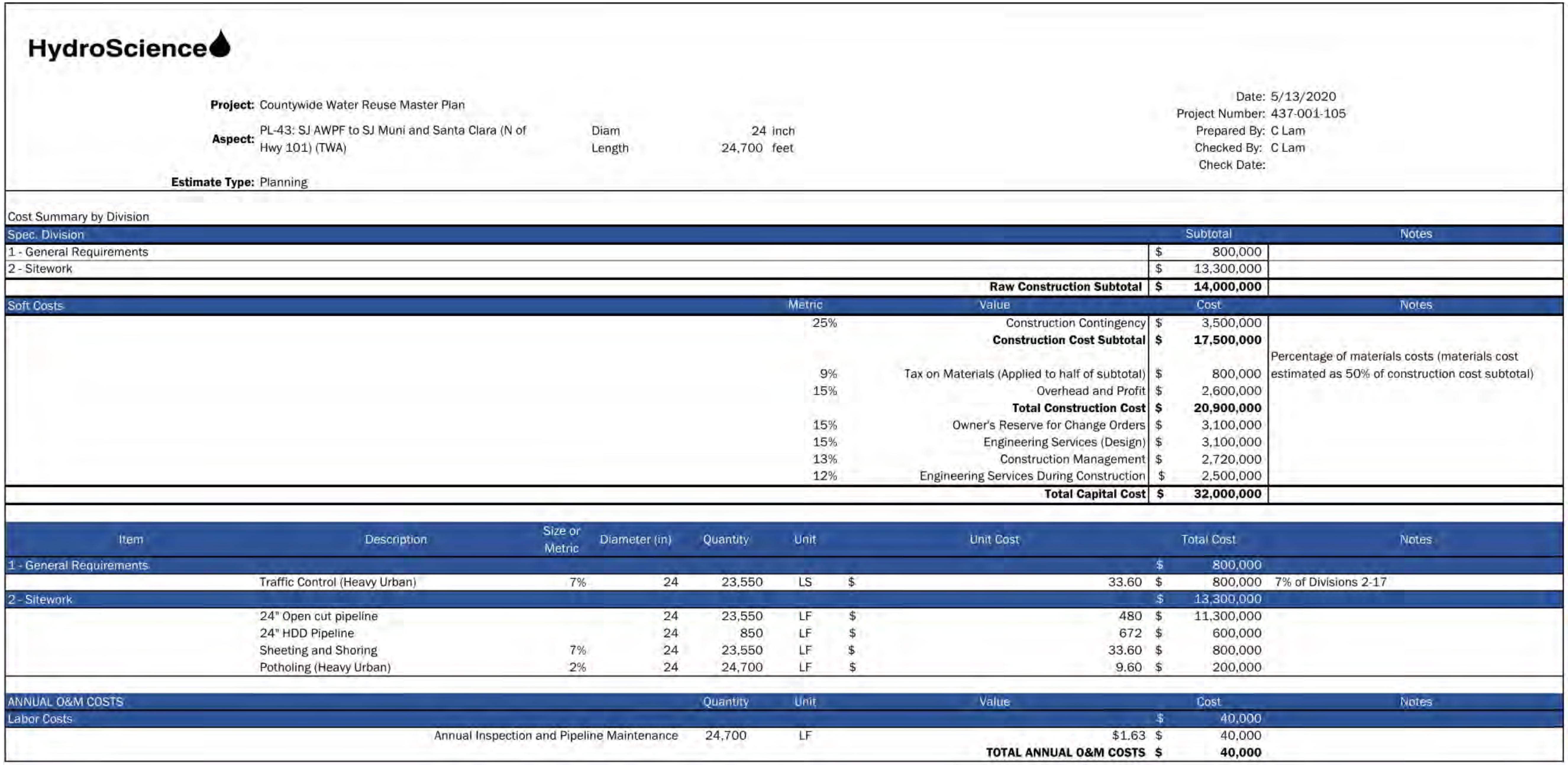
Spec. Division	Metric	Value		Subtotal	Notes
1 - General Requirements			$	2,000,000	
2 - Sitework			$	34,400,000	
		Raw Construction Subtotal	**$**	**37,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	9,250,000	
		Construction Cost Subtotal	**$**	**46,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	2,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	6,900,000	
		Total Construction Cost	**$**	**55,250,000**	
	15%	Owner's Reserve for Change Orders	$	8,300,000	
	15%	Engineering Services (Design)	$	8,300,000	
	13%	Construction Management	$	7,180,000	
	12%	Engineering Services During Construction	$	6,600,000	
		Total Capital Cost	**$**	**86,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	2,000,000	
	Traffic Control (Heavy Urban)	7%	36	40,450	LS	$	50.40	$	2,000,000	7% of Divisions 2-17
2 - Sitework								$	34,400,000	
	36" Open cut pipeline		36	40,450	LF	$	720	$	29,100,000	
	36" HDD Pipeline		36	2,650	LF	$	1,008	$	2,700,000	
	Sheeting and Shoring	7%	36	40,450	LF	$	50.40	$	2,000,000	
	Potholing (Heavy Urban)	2%	36	43,100	LF	$	14.40	$	600,000	

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Labor Costs					$	70,000	
	Annual Inspection and Pipeline Maintenance	43,100	LF	$1.63	$	70,000	
				TOTAL ANNUAL O&M COSTS	**$**	**70,000**	

Table 19. PL-43, 24-inch purified water pipeline from San José AWPF to delivery point North of Hwy 101 in Santa Clara (Portfolios 1d)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PL-43: SJ AWPF to SJ Muni and Santa Clara (N of Hwy 101) (TWA)
Diam 24 inch
Length 24,700 feet
Estimate Type: Planning

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 800,000	
2 - Sitework			$ 13,300,000	
		Raw Construction Subtotal	**$ 14,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,500,000	
		Construction Cost Subtotal	**$ 17,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,600,000	
		Total Construction Cost	**$ 20,900,000**	
	15%	Owner's Reserve for Change Orders	$ 3,100,000	
	15%	Engineering Services (Design)	$ 3,100,000	
	13%	Construction Management	$ 2,720,000	
	12%	Engineering Services During Construction	$ 2,500,000	
		Total Capital Cost	**$ 32,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 800,000	
	Traffic Control (Heavy Urban)	7%	24	23,550	LS	$ 33.60	$ 800,000	7% of Divisions 2-17
2 - Sitework							$ 13,300,000	
	24" Open cut pipeline		24	23,550	LF	$ 480	$ 11,300,000	
	24" HDD Pipeline		24	850	LF	$ 672	$ 600,000	
	Sheeting and Shoring	7%	24	23,550	LF	$ 33.60	$ 800,000	
	Potholing (Heavy Urban)	2%	24	24,700	LF	$ 9.60	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 40,000	
	Annual Inspection and Pipeline Maintenance	24,700	LF	$1.63	$ 40,000	
				TOTAL ANNUAL O&M COSTS	**$ 40,000**	

Table 20. PS-16, pump station to convey San José AWPF purified water to Penitenica WTP modulating valve vault via PL-42 (Portfolio 1d)

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-16. Purified water from San José AWPF to PWTP mod valve through new PL (TWA)
Estimate Type: Planning

Flow 16,667 gpm
TDH 350 feet
Horsepower 2,500 hp

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,670,000	
2 - Sitework	$	1,900,000	
3 - Concrete	$	1,930,000	
11 - Equipment	$	2,000,000	
15 - Mechanical	$	1,050,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**14,350,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,590,000	
		Construction Cost Subtotal	**$**	**17,940,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	810,000	
	15%	Overhead and Profit	$	2,690,000	
		Total Construction Cost	**$**	**21,440,000**	
	15%	Owner's Reserve for Change Orders	$	3,220,000	
	15%	Engineering Services (Design)	$	3,220,000	
	13%	Construction Management	$	2,790,000	
	12%	Engineering Services During Construction	$	2,570,000	
		TOTAL CAPITAL COST	**$**	**33,240,000**	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							$	1,670,000	
	Mobilization/Demobilization	10%		1	LS		$	1,268,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	400,000	
2 - Sitework							$	1,900,000	
	Site Preparation, Excavation, and Offhauling			1	LS		$	500,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	350,000	
	Finish Grading, Compaction			1	LS		$	75,000	
	Dewatering			1	LS		$	75,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	100,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	300,000	
	Landscaping and irrigation			1	LS		$	100,000	
3 - Concrete							$	1,930,000	
	Structural Concrete	18	inch	1	LS		$	520,000	
	Vaults	12	inch	1	LS		$	260,000	
	Equipment slabs	12	inch	1	LS		$	200,000	
	Building slabs	18	inch	1	LS		$	150,000	
	Miscellaneous Concrete	18	inch	1	LS		$	300,000	
	CMU Building	40 X 50	foot	1	LS		$	500,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 2,000,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 1,500,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 400,000	
15 - Mechanical						$ 1,050,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 250,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 3,300,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						$ 2,500,000	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 177,000	
	Equipment		2%		$2,000,000	$ 40,000	2% of Division 11
	Mechanical		2%		$1,050,000	$ 21,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						$ 2,351,000	
	Electricity Requirement	2,500 hp	14,695,566	kWh	$0.16	$ 2,351,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,528,000**	

Table 21. PS-17, pump station to convey San José AWPF purified water to delivery point North of Hwy 101 in Santa Clara (Portfolio 1d)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-17. Purified water from San José AWPF to Santa Clara (N of Hwy 101) (TWA)

Estimate Type: Planning

Flow	8,333	gpm
TDH	250	feet
Horsepower	890	hp

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 750,000	
2 - Sitework	$ 1,050,000	
3 - Concrete	$ 780,000	
11 - Equipment	$ 650,000	
15 - Mechanical	$ 540,000	
16 - Electrical	$ 1,750,000	
17 - Instrumentation and Control	$ 1,250,000	
Raw Construction Subtotal	**$ 6,770,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,690,000	
		Construction Cost Subtotal	**$ 8,460,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 380,000	
	15%	Overhead and Profit	$ 1,270,000	
		Total Construction Cost	**$ 10,110,000**	
	15%	Owner's Reserve for Change Orders	$ 1,520,000	
	15%	Engineering Services (Design)	$ 1,520,000	
	13%	Construction Management	$ 1,310,000	
	12%	Engineering Services During Construction	$ 1,210,000	
		TOTAL CAPITAL COST	**$ 15,670,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 750,000	
	Mobilization/Demobilization	10%	1	LS		$ 602,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						$ 1,050,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 200,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 100,000	
	Landscaping and irrigation		1	LS		$ 50,000	
3 - Concrete						$ 780,000	
	Structural Concrete	18 inch	1	LS		$ 300,000	
	Vaults	12 inch	1	LS		$ 100,000	
	Equipment slabs	12 inch	1	LS		$ 50,000	
	Building slabs	18 inch	1	LS		$ 50,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 75,000	
	CMU Building	40 X 50 foot	1	LS		$ 200,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 650,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 450,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 125,000	
15 - Mechanical						$ 540,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 140,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 400,000	
16 - Electrical						$ 1,750,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,250,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						$ 1,250,000	
	I&C/SCADA/Programming Allowance					$ 1,250,000	

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 83,800	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$540,000	$ 10,800	2% of Division 15
	Electrical		2%		$1,750,000	$ 35,000	2% of Division 16
	Instrumentation		2%		$1,250,000	$ 25,000	2% of Division 17
Power Costs						$ 837,000	
	Electricity Requirement	890 hp	5,233,464	kWh	$0.16	$ 837,000	
					TOTAL ANNUAL O&M COSTS	**$ 920,800**	

Portfolio 2a cost estimate details

Table 22. Combined Regional AWPF in Palo Alto; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2a)

Focus: Cost Summary
Element: AWPF (GWR)
Capacity / Treatment: 24.5 mgd
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**130,000,000**
Contingency - Treatment Facility	25%	$	33,000,000
Construction Cost Subtotal		**$**	**163,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	25,000,000
Estimated Total Construction Cost		**$**	**196,000,000**
Owner's Reserve for Change Orders	15%	$	30,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	30,000,000
Construction Management	13%	$	26,000,000
Engineering Services During Construction	12%	$	24,000,000
Total Capital Cost		**$**	**306,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,500,000
Energy/Power	$	5,390,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,580,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	172,000,000
30-yr Lifecycle (present value, $2019)	$	75,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	15,610,000
Annual O&M Cost		$	13,580,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,500,000
Total Annual Cost		**$**	**31,690,000**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,720**

Construction Costs by Division	Cost Summary		% of Total Cost
Division 01 - General Requirements	$	11,829,800	9%
Division 02 - Site Construction	$	-	0%
Division 03 - Concrete	$	7,131,400	5%
Division 04 - Masonry	$	-	0%
Division 05 - Metals	$	750,000	1%
Division 06 - Woods, Plastics, and Composites	$	-	0%
Division 07 - Thermal and Moisture Protection	$	-	0%
Division 08 - Doors and Windows	$	-	0%
Division 09 - Finishes	$	1,000,000	1%
Division 10 - Specialties	$	-	0%
Division 11 - Equipment	$	-	0%
Division 12 - Furnishings	$	-	0%
Division 13 - Special Construction	$	-	0%
Division 14 - Conveying Systems	$	-	0%
Division 15 - Mechanical	$	-	0%
Division 17 - Instrumentation	$	4,183,400	3%
Division 21 - Fire Suppression	$	-	0%
Division 22 - Plumbing	$	-	0%
Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 - Electrical	$	16,733,600	13%
Division 27 - Communications	$	-	0%
Division 28 - Electronic Safety and Security	$	-	0%
Division 31 - Earthwork	$	4,040,800	3%
Division 32 - Exterior Improvements	$	111,200	0%
Division 33 - Utilities	$	-	0%
Division 40 - Process Integration	$	16,943,700	13%
Division 41 - Material Processing and Handling Equipment	$	-	0%
Division 42 - Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	$	18,291,800	14%
Division 44 - Pollution and Waste Control Equipment	$	-	0%
Division 46 - Water and Wastewater Equipment	$	49,112,000	38%
TOTAL	**$**	**130,000,000**	

Brown AND Caldwell

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24.5 mgd
Location: Palo Alto

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 118,297,900	10% of Divisions 2-47	$ 11,829,800	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		37,566	CY		$ 11.78			$ 442,600	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		12,781	SY		$ 4.63			$ 59,200	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24.5 mgd
Location: Palo Alto

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24.5 mgd
Location: Palo Alto

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank	$ 3,650,000	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 49,112,000	30% of Equipment Costs	$ 14,733,600	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 49,112,000	30% of Equipment Costs	$ 14,733,600	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 16,733,600	25% of Electrical Costs	$ 4,183,400	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,220,000	2% of Pumping Equipment Cost	$ 24,400	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,733,600	2% of Electrical Cost	$ 334,700	

Focus: Cost Inputs and R&R
Aspect: AWPF (GWR)
Capacity: 24.5 mgd
Location: Palo Alto

Date: 11/9/2020
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Estimate Version Number: 2.0
Estimate Date: R. Guillen
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,183,400	2% of Instrumentation & Controls Cost	$ 83,700	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,176,293	kWh		$ 0.10			$ 121,700	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 23. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 2a)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF	**Diam**	36 inch	Prepared By:	N Venugopal
		Length	15,150 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

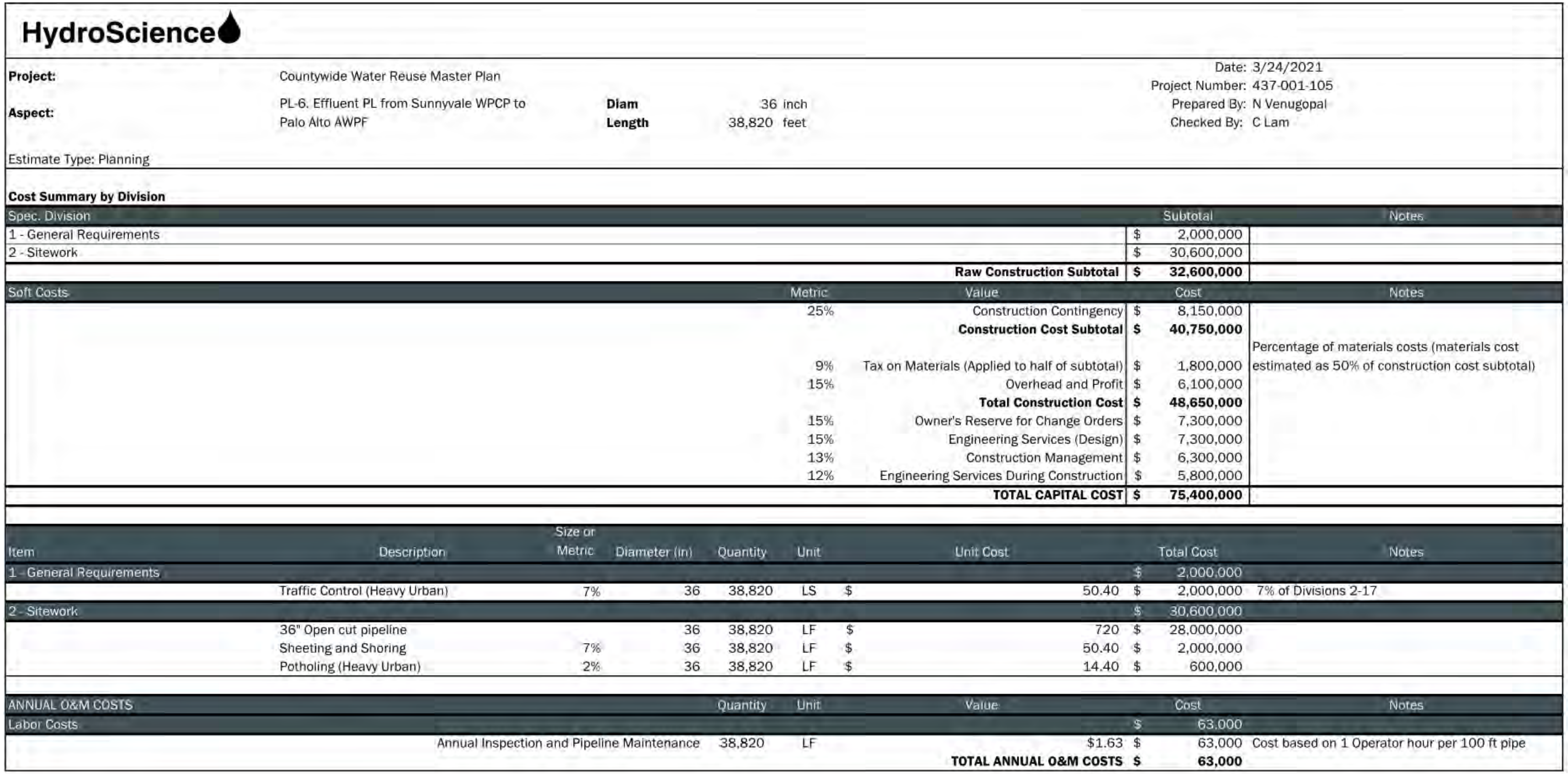
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 700,000	
2 - Sitework	$ 12,000,000	
Raw Construction Subtotal	**$ 12,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,175,000	
		Construction Cost Subtotal	**$ 15,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,400,000	
		Total Construction Cost	**$ 18,975,000**	
	15%	Owner's Reserve for Change Orders	$ 2,800,000	
	15%	Engineering Services (Design)	$ 2,800,000	
	13%	Construction Management	$ 2,500,000	
	12%	Engineering Services During Construction	$ 2,300,000	
		TOTAL CAPITAL COST	**$ 29,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 700,000	
	Traffic Control (Heavy Urban)	7%	36	14,500	LS	$ 50.40	$ 700,000	7% of Divisions 2-17
2 - Sitework							$ 12,000,000	
	36" Open cut pipeline		36	14,500	LF	$ 720	$ 10,400,000	
	36" HDD Pipeline		36	650	LF	$ 1,008	$ 700,000	
	Sheeting and Shoring	7%	36	14,500	LF	$ 50.40	$ 700,000	
	Potholing (Heavy Urban)	2%	36	15,150	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 25,000	
	Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$ 25,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 25,000**	

Table 24. PL-6, 36-inch effluent pipeline from Sunnyvale WPCP to Palo Alto AWPF (Portfolio 2a)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-6. Effluent PL from Sunnyvale WPCP to Palo Alto AWPF	**Diam**	36 inch	Prepared By:	N Venugopal
		Length	38,820 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

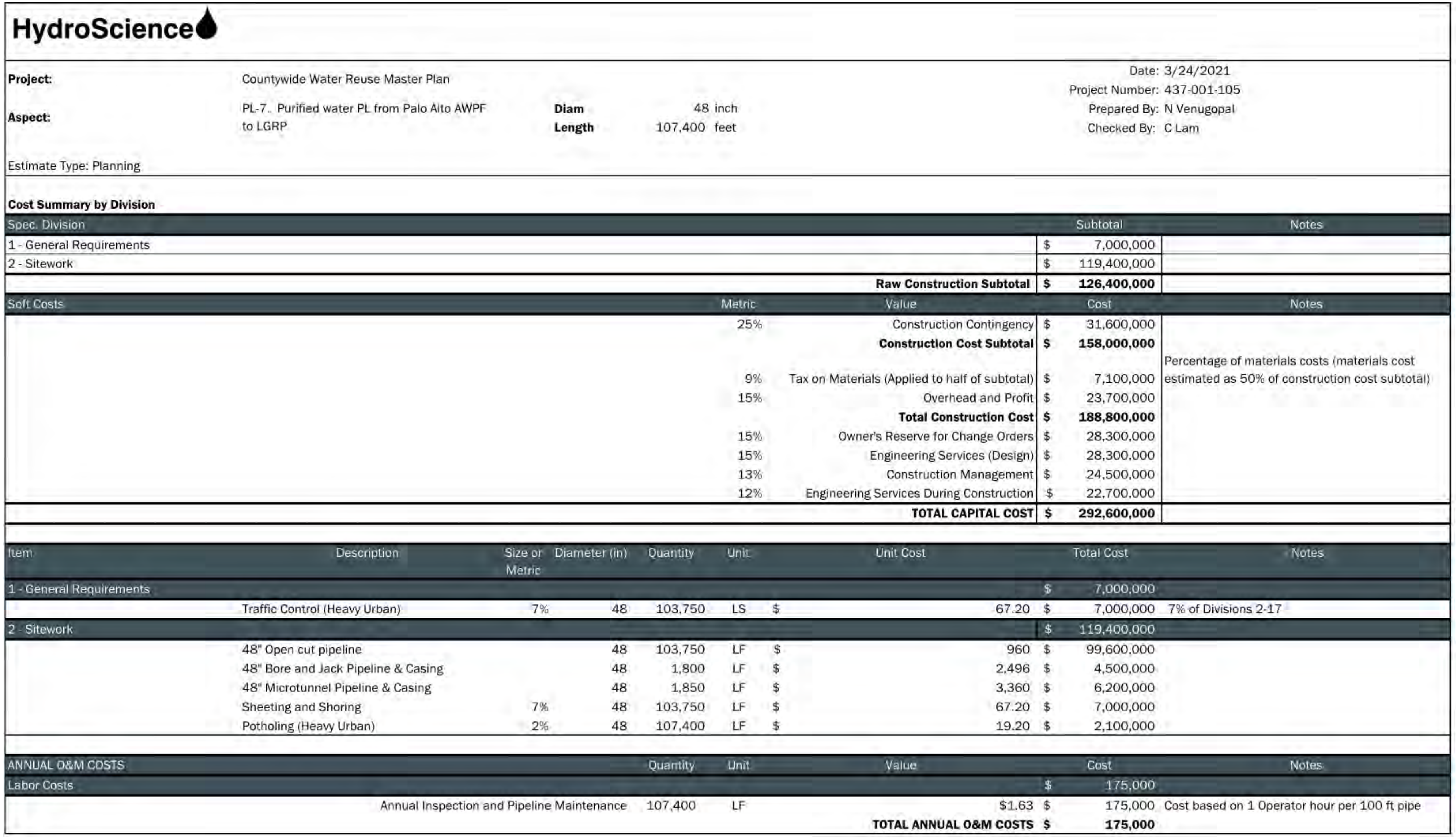
Spec. Division		Subtotal	Notes
1 - General Requirements	$	2,000,000	
2 - Sitework	$	30,600,000	
Raw Construction Subtotal	**$**	**32,600,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	8,150,000	
		Construction Cost Subtotal	**$**	**40,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	6,100,000	
		Total Construction Cost	**$**	**48,650,000**	
	15%	Owner's Reserve for Change Orders	$	7,300,000	
	15%	Engineering Services (Design)	$	7,300,000	
	13%	Construction Management	$	6,300,000	
	12%	Engineering Services During Construction	$	5,800,000	
		TOTAL CAPITAL COST	**$**	**75,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							$	2,000,000	
	Traffic Control (Heavy Urban)	7%	36	38,820	LS	$ 50.40	$	2,000,000	7% of Divisions 2-17
2 - Sitework							$	30,600,000	
	36" Open cut pipeline		36	38,820	LF	$ 720	$	28,000,000	
	Sheeting and Shoring	7%	36	38,820	LF	$ 50.40	$	2,000,000	
	Potholing (Heavy Urban)	2%	36	38,820	LF	$ 14.40	$	600,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	63,000	
Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$	63,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**63,000**	

Table 25. PL-7, 48-inch purified water pipeline from Palo Alto AWPF to LGRP (Portfolio 2a)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-7. Purified water PL from Palo Alto AWPF to LGRP	**Diam**	48 inch	Prepared By:	N Venugopal
		Length	107,400 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 7,000,000	
2 - Sitework	$ 119,400,000	
Raw Construction Subtotal	**$ 126,400,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 31,600,000	
		Construction Cost Subtotal	**$ 158,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 7,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 23,700,000	
		Total Construction Cost	**$ 188,800,000**	
	15%	Owner's Reserve for Change Orders	$ 28,300,000	
	15%	Engineering Services (Design)	$ 28,300,000	
	13%	Construction Management	$ 24,500,000	
	12%	Engineering Services During Construction	$ 22,700,000	
		TOTAL CAPITAL COST	**$ 292,600,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 7,000,000	
	Traffic Control (Heavy Urban)	7%	48	103,750	LS	$ 67.20	$ 7,000,000	7% of Divisions 2-17
2 - Sitework							$ 119,400,000	
	48" Open cut pipeline		48	103,750	LF	$ 960	$ 99,600,000	
	48" Bore and Jack Pipeline & Casing		48	1,800	LF	$ 2,496	$ 4,500,000	
	48" Microtunnel Pipeline & Casing		48	1,850	LF	$ 3,360	$ 6,200,000	
	Sheeting and Shoring	7%	48	103,750	LF	$ 67.20	$ 7,000,000	
	Potholing (Heavy Urban)	2%	48	107,400	LF	$ 19.20	$ 2,100,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 175,000	
	Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table 26. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 2a)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-3. Effluent from PA RWQCP to PA AWPF

Estimate Type: Planning

Flow	12,000	gpm
TDH	100	feet
Horsepower	508	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

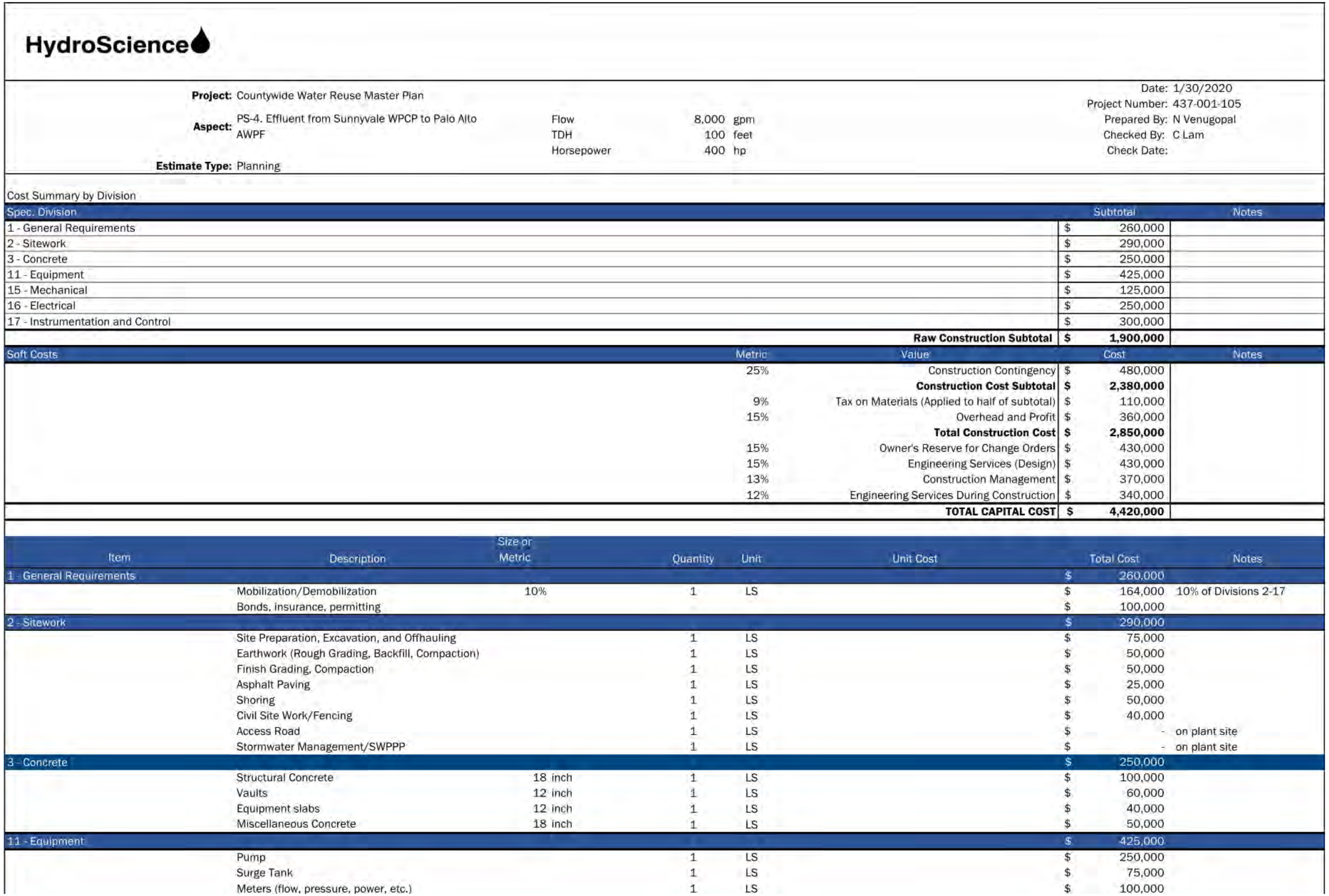
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 260,000	
2 - Sitework	$ 290,000	
3 - Concrete	$ 250,000	
11 - Equipment	$ 425,000	
15 - Mechanical	$ 125,000	
16 - Electrical	$ 250,000	
17 - Instrumentation and Control	$ 300,000	
Raw Construction Subtotal	**$ 1,900,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 480,000	
		Construction Cost Subtotal	**$ 2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 110,000	
	15%	Overhead and Profit	$ 360,000	
		Total Construction Cost	**$ 2,850,000**	
	15%	Owner's Reserve for Change Orders	$ 430,000	
	15%	Engineering Services (Design)	$ 430,000	
	13%	Construction Management	$ 370,000	
	12%	Engineering Services During Construction	$ 340,000	
		TOTAL CAPITAL COST	**$ 4,420,000**	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 260,000	
	Mobilization/Demobilization	10%		1	LS		$ 164,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$ 100,000	
2 - Sitework							$ 290,000	
	Site Preparation, Excavation, and Offhauling			1	LS		$ 75,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$ 50,000	
	Finish Grading, Compaction			1	LS		$ 50,000	
	Asphalt Paving			1	LS		$ 25,000	
	Shoring			1	LS		$ 50,000	
	Civil Site Work/Fencing			1	LS		$ 40,000	
	Access Road			1	LS		$ -	on plant site
	Stormwater Management/SWPPP			1	LS		$ -	on plant site
3 - Concrete							$ 250,000	
	Structural Concrete	18	inch	1	LS		$ 100,000	
	Vaults	12	inch	1	LS		$ 60,000	
	Equipment slabs	12	inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18	inch	1	LS		$ 50,000	
11 - Equipment							$ 425,000	
	Pump			1	LS		$ 250,000	
	Surge Tank			1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)			1	LS		$ 100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
15 - Mechanical						$ 125,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						$ 250,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						$ 300,000	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 22,000	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						$ 567,000	
	Electricity Requirement	508 hp	2,986,139	kWh	$0.19	$ 567,000	
					TOTAL ANNUAL O&M COSTS	**$ 589,000**	

Table 27. PS-4, pump station to convey Sunnyvale WPCP effluent to Palo Alto AWPF (Portfolio 2a)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-4. Effluent from Sunnyvale WPCP to Palo Alto AWPF
Estimate Type: Planning

Flow	8,000	gpm
TDH	100	feet
Horsepower	400	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

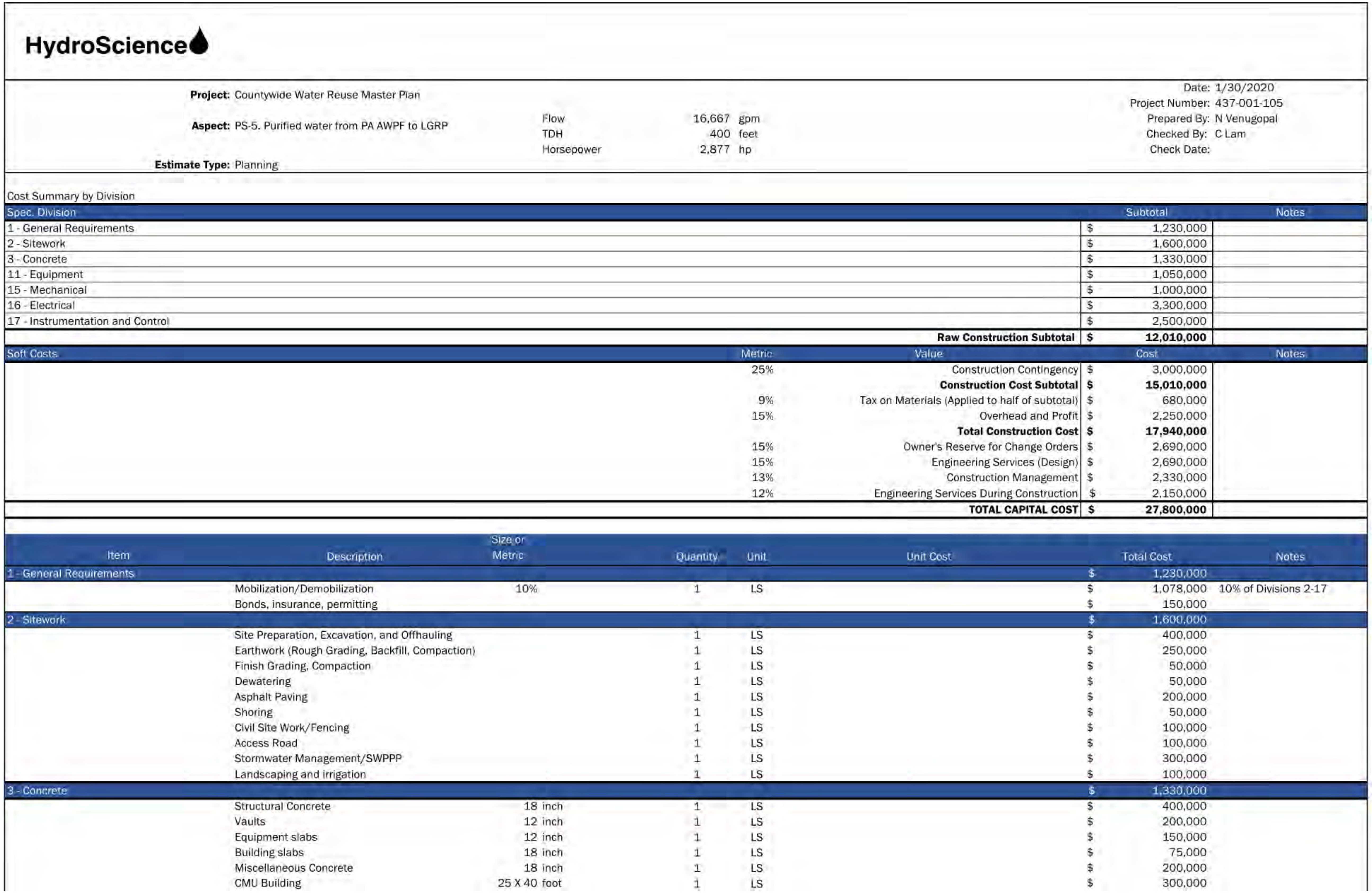
Spec. Division		Subtotal	Notes
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	260,000	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						$	290,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
	Access Road		1	LS		$	-	on plant site
	Stormwater Management/SWPPP		1	LS		$	-	on plant site
3 - Concrete						$	250,000	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	
	Miscellaneous Concrete	18 inch	1	LS		$	50,000	
11 - Equipment						$	425,000	
	Pump		1	LS		$	250,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
15 - Mechanical						$ 125,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						$ 250,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						$ 300,000	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 22,000	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						$ 376,000	
	Electricity Requirement	400 hp	2,351,291	kWh	$0.16	$ 376,000	
					TOTAL ANNUAL O&M COSTS	**$ 398,000**	

Table 28. PS-5, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 2a)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-5. Purified water from PA AWPF to LGRP

Estimate Type: Planning

Flow	16,667	gpm
TDH	400	feet
Horsepower	2,877	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							$	1,230,000	
	Mobilization/Demobilization	10%		1	LS		$	1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	150,000	
2 - Sitework							$	1,600,000	
	Site Preparation, Excavation, and Offhauling			1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	250,000	
	Finish Grading, Compaction			1	LS		$	50,000	
	Dewatering			1	LS		$	50,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	50,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	300,000	
	Landscaping and irrigation			1	LS		$	100,000	
3 - Concrete							$	1,330,000	
	Structural Concrete	18	inch	1	LS		$	400,000	
	Vaults	12	inch	1	LS		$	200,000	
	Equipment slabs	12	inch	1	LS		$	150,000	
	Building slabs	18	inch	1	LS		$	75,000	
	Miscellaneous Concrete	18	inch	1	LS		$	200,000	
	CMU Building	25 X 40	foot	1	LS		$	300,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 1,050,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						$ 1,000,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 3,300,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						$ 2,500,000	
	I&C/SCADA/Programming Allowance					$ 2,500,000	

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 157,000	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						$ 3,213,000	
	Electricity Requirement	2,877 hp	16,911,657	kWh	$0.19	$ 3,213,000	
					TOTAL ANNUAL O&M COSTS	**$ 3,370,000**	

Table 29. LGRP site improvements (Portfolio 2a)

		2019 Estimate (Escalated to $2019)
Divisions		Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		O&M Costs
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

Project:	SCVWD Purified Water Program Preliminary Engineering Services	Date:	7-Sep-17
		Project Number:	0027-016
		Prepared By:	R. Doyle/J. Yan/M. Wong
Aspect:	Los Gatos Pond - Baseline Configuration ($2017)	Checked By:	G. Hermanson/E. Roy
		Check Date:	26-Sep-17
Estimate Type:	Planning		

Process Cost Summary by Division

Spec. Division		Subtotal (2017 $)	Notes
1 - General Requirements	$	579,000	
2 - Sitework	$	4,037,000	
16 - Electrical	$	60,000	
17 - Instrumentation and Control	$	40,000	
Subtotal	**$**	**4,716,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							$ 579,000	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							$ 4,037,000	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Sunnyoaks Facilities									
18", PVC, 8' Cover	18	in-dia	1,180	LF	$	334	$	394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	3%		1	LS	$	11,820	$	12,000	Up to 8' of cover
Potholing			12	EA	$	3,600	$	42,000	Light Urban, $3,600 per 100 feet of pipe
30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import. 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

				Quantity	Unit	Value	Cost	Notes
	Kirk Ditch Facilities							
	36", MLCSP, 12' Cover	36	in-dia	40	Allow	$ 545	$ 22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 1,100	$ 1,000	9' to 14' of cover
	Potholing			0	EA	$ 1,200	$ -	Rural, $1,200 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
16 - Electrical							$ 60,000	
	Electrical Allowance			4	EA	$15,000	$ 60,000	Engineers Estimate
17 - I&C							$ 40,000	
	I&C Allowance			4	EA	$10,000	$ 40,000	Engineers Estimate

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					$ 10,000	
	Mechanical	2%		$487,000	$ 10,000	2% of Valves and Meters
Labor Costs					$ 315,000	
	Pond Maintenance	68	AC	$4,531	$ 307,000	Engineer's estimate
	Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$ 8,000	Engineer's estimate
				TOTAL ANNUAL O&M COSTS	**$ 325,000**	

Portfolio 2b cost estimate details

Table 30. Combined Regional AWPF in Sunnyvale; 24 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 2b)

Brown AND Caldwell

Focus: Cost Summary
Element: AWPF
Capacity / Treatment: 24.5 mgd
Location: Sunnyvale

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**134,000,000**
Contingency - Treatment Facility	25%	$	34,000,000
Construction Cost Subtotal		**$**	**168,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	8,000,000
General Contractor Overhead and Profit	15%	$	26,000,000
Estimated Total Construction Cost		**$**	**202,000,000**
Owner's Reserve for Change Orders	15%	$	31,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	31,000,000
Construction Management	13%	$	27,000,000
Engineering Services During Construction	12%	$	25,000,000
Total Capital Cost		**$**	**316,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,500,000
Energy/Power	$	5,350,000
Chemicals	$	2,890,000
Labor	$	2,800,000
Total Annual O&M Cost	**$**	**13,540,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	172,000,000
30-yr Lifecycle (present value, $2019)	$	74,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	16,120,000
Annual O&M Cost		$	13,540,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,470,000
Total Annual Cost		**$**	**32,130,000**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,740**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	12,219,100	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	7,845,400	6%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	750,000	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	1,000,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	4,183,400	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	16,733,600	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,932,600	3%
Division 32 – Exterior Improvements	$	130,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	16,943,700	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	21,559,500	16%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	49,112,000	37%
TOTAL	**$**	**134,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF
Capacity: 24.5 mgd
Location: Sunnyvale

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$122,190,500	10% of Divisions 2-47	$ 12,219,100	
Division 31 – Earthwork	Sitework	Site Clear and Grub		8	Acre		$ 7,760			$ 64,100	
Division 31 – Earthwork	Sitework	Excavation		43,416	CY		$ 11.78			$ 511,500	
Division 31 – Earthwork	Sitework	Site Specific Site Prep. for Recycle Hill		1	LS			See Note		See Note	Site-specific prep work for Recycle Hill included in costs at the portfolio level (See App A-1, Table D-11). Based on estimate prepared by City of Sunnyvale staff in 2016. The original estimate was rounded up to $40 million and escalated to 2019 dollars. This cost is not subject to construction markup/ escalation factors.
Division 31 – Earthwork	Sitework	Compaction		19,965	CY		$ 0.89			$ 17,800	
Division 31 – Earthwork	Sitework	Grading		39,930	SY		$ 1.18			$ 47,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		14,084	CY		$ 58.49			$ 823,800	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		9,479	SY		$ 4.63			$ 43,900	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 179,539		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 179,600	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,075,269			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,075,300	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		500	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 187,300	Unit cost obtained by interpolating available data.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 187,300	9' to 14' of cover	$ 9,400	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		5	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 6,200	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		5,622	CY		$ 645		See Site Work and Concrete Tab	$ 3,626,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical

Focus: Cost Inputs and R&R
Aspect: AWPF
Capacity: 24.5 mgd
Location: Sunnyvale

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,460	LF		$ 52.94			$ 130,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing

Focus: Cost Inputs and R&R
Aspect: AWPF
Capacity: 24.5 mgd
Location: Sunnyvale

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		75,900	SF		$ 218.58		330' x 230'; furnished and installed	$ 16,590,100	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank	$ 3,650,000	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 49,112,000	30% of Equipment Costs	$ 14,733,600	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 14,733,600	5% of Piping Allowance	$ 736,700	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 49,112,000	30% of Equipment Costs	$ 14,733,600	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 16,733,600	25% of Electrical Costs	$ 4,183,400	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor

Focus: Cost Inputs and R&R
Aspect: AWPF
Capacity: 24.5 mgd
Location: Sunnyvale

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,220,000	2% of Pumping Equipment Cost	$ 24,400	
O&M	Consumables	Electrical Consumables		2%	% of			$ 16,733,600	2% of Electrical Cost	$ 334,700	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 4,183,400	2% of Instrumentation & Controls Cost	$ 83,700	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96.000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	Assumes three plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 31. PL-8, 36-inch effluent pipeline from Palo Alto RWQCP to Sunnyvale AWPF (Portfolio 2b)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date: 3/24/2021
				Project Number: 437-001-105
Aspect:	PL-8. Effluent PL, Palo Alto RWQCP to Sunnyvale AWPF	**Diam**	36 inch	Prepared By: N Venugopal
		Length	52,950 feet	Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 2,600,000	
2 - Sitework	$ 41,900,000	
Raw Construction Subtotal	**$ 44,500,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 11,125,000	
		Construction Cost Subtotal	**$ 55,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 2,500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 8,300,000	
		Total Construction Cost	**$ 66,425,000**	
	15%	Owner's Reserve for Change Orders	$ 10,000,000	
	15%	Engineering Services (Design)	$ 10,000,000	
	13%	Construction Management	$ 8,600,000	
	12%	Engineering Services During Construction	$ 8,000,000	
		TOTAL CAPITAL COST	**$ 103,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 2,600,000	
	Traffic Control (Heavy Urban)	7%	36	51,800	LS	$ 50.40	$ 2,600,000	7% of Divisions 2-17
2 - Sitework							$ 41,900,000	
	36" Open cut pipeline		36	51,800	LF	$ 720	$ 37,300,000	
	36" HDD Pipeline		36	1,150	LF	$ 1,008	$ 1,200,000	
	Sheeting and Shoring	7%	36	51,800	LF	$ 50.40	$ 2,600,000	
	Potholing (Heavy Urban)	2%	36	52,950	LF	$ 14.40	$ 800,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 86,000	
Annual Inspection and Pipeline Maintenance	52,950	LF	$1.63	$ 86,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 86,000**	

Table 32. PL-9, 48-inch purified water pipeline from Sunnyvale AWPF to LGRP (Portfolio 2b)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-9. Purified water PL, Sunnyvale AWPF to LGRP	**Diam**	48 inch	Prepared By:	N Venugopal
		Length	90,230 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 5,900,000	
2 - Sitework	$ 101,800,000	
Raw Construction Subtotal	**$ 107,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 26,925,000	
		Construction Cost Subtotal	**$ 134,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 20,200,000	
		Total Construction Cost	**$ 160,925,000**	
	15%	Owner's Reserve for Change Orders	$ 24,100,000	
	15%	Engineering Services (Design)	$ 24,100,000	
	13%	Construction Management	$ 20,900,000	
	12%	Engineering Services During Construction	$ 19,300,000	
		TOTAL CAPITAL COST	**$ 249,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 5,900,000	
	Traffic Control (Heavy Urban)	7%	48	87,080	LS	$ 67.20	$ 5,900,000	7% of Divisions 2-17
2 - Sitework							$ 101,800,000	
	48" Open cut pipeline		48	87,080	LF	$ 960	$ 83,600,000	
	48" Microtunnel Pipeline & Casing		48	3,150	LF	$ 3,360	$ 10,600,000	
	Sheeting and Shoring	7%	48	87,080	LF	$ 67.20	$ 5,900,000	
	Potholing (Heavy Urban)	2%	48	90,230	LF	$ 19.20	$ 1,700,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 147,000	
	Annual Inspection and Pipeline Maintenance	90,230	LF	$1.63	$ 147,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 147,000**	

Table 33. PS-6, pump station to convey Palo Alto RWQCP effluent to Sunnyvale AWPF (Portfolio 2b)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-6. Effluent from PA RWQCP to Sunnyvale AWPF

Estimate Type: Planning

Flow	12,000	gpm
TDH	100	feet
Horsepower	508	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

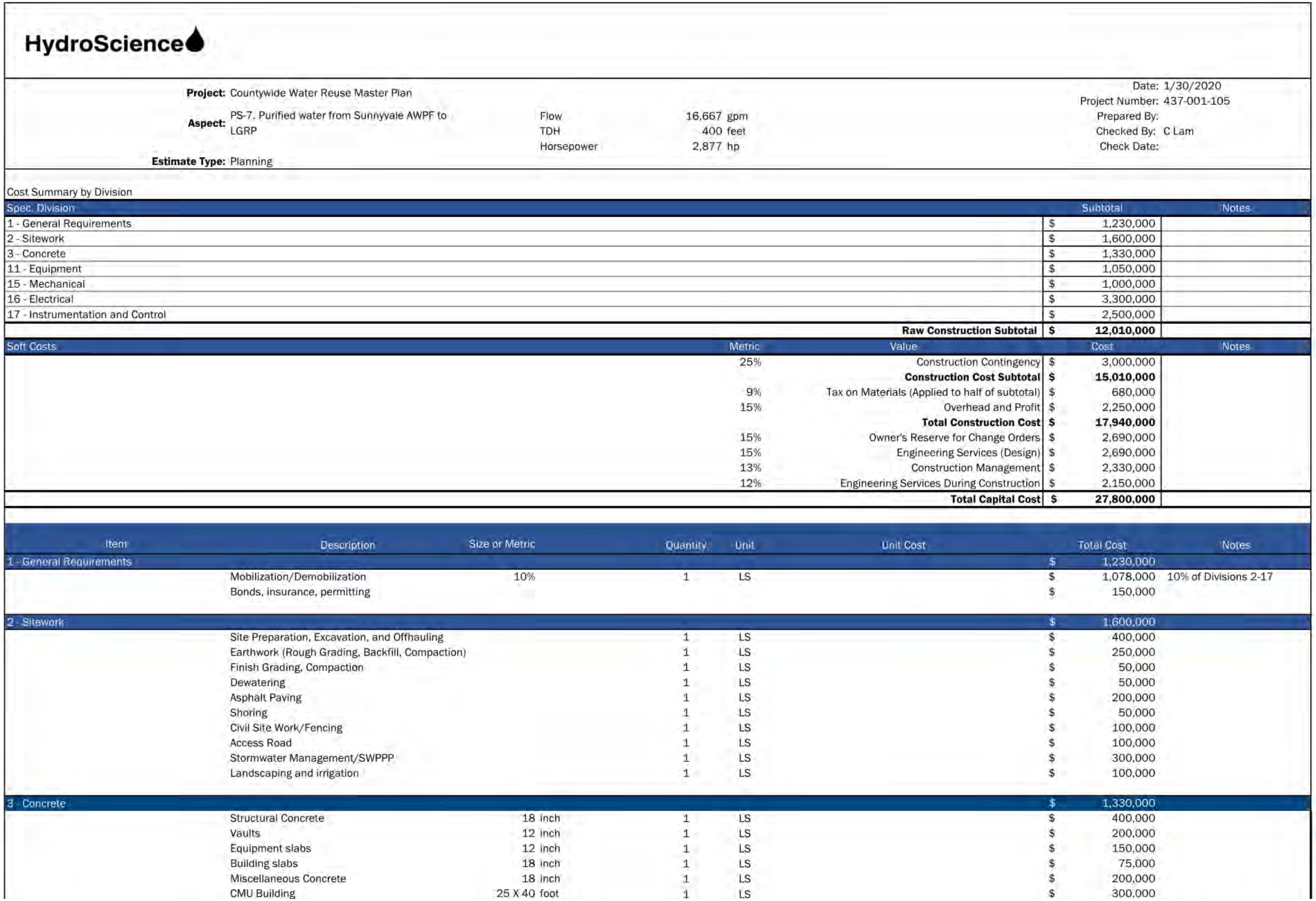
Spec. Division		Subtotal	Notes
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	260,000	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						$	290,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
3 - Concrete						$	250,000	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	
	Miscellaneous Concrete	18 inch	1	LS		$	50,000	
11 - Equipment						$	425,000	
	Pump		1	LS		$	250,000	
	Surge Tank		1	LS		$	75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
15 - Mechanical						$ 125,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						$ 250,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						$ 300,000	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 22,000	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						$ 567,000	
	Electricity Requirement	508 hp	2,986,139	kWh	$0.19	$ 567,000	
					TOTAL ANNUAL O&M COSTS	**$ 589,000**	

Table 34. PS-7, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 2b)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-7. Purified water from Sunnyvale AWPF to LGRP
Estimate Type: Planning

Flow	16,667	gpm
TDH	400	feet
Horsepower	2,877	hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By:
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		Total Capital Cost	**$**	**27,800,000**	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							$	1,230,000	
	Mobilization/Demobilization	10%		1	LS		$	1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting						$	150,000	
2 - Sitework							$	1,600,000	
	Site Preparation, Excavation, and Offhauling			1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)			1	LS		$	250,000	
	Finish Grading, Compaction			1	LS		$	50,000	
	Dewatering			1	LS		$	50,000	
	Asphalt Paving			1	LS		$	200,000	
	Shoring			1	LS		$	50,000	
	Civil Site Work/Fencing			1	LS		$	100,000	
	Access Road			1	LS		$	100,000	
	Stormwater Management/SWPPP			1	LS		$	300,000	
	Landscaping and irrigation			1	LS		$	100,000	
3 - Concrete							$	1,330,000	
	Structural Concrete	18	inch	1	LS		$	400,000	
	Vaults	12	inch	1	LS		$	200,000	
	Equipment slabs	12	inch	1	LS		$	150,000	
	Building slabs	18	inch	1	LS		$	75,000	
	Miscellaneous Concrete	18	inch	1	LS		$	200,000	
	CMU Building	25 X 40	foot	1	LS		$	300,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 1,050,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						$ 1,000,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 3,300,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						$ 2,500,000	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 157,000	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						$ 2,706,000	
	Electricity Requirement	2,877 hp	16,911,657	kWh	$0.16	$ 2,706,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,863,000**	

Table 35. LGRP site improvements (Portfolio 2b)

		2019 Estimate (Escalated to $2019)
Divisions		Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		O&M Costs
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	**$ 4,716,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							$ 579,000	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							$ 4,037,000	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate

RMC water and environment

Project:	SCVWD Purified Water Program Preliminary Engineering Services	Date:	7-Sep-17
		Project Number:	0027-016
Aspect:	Los Gatos Pond - Baseline Configuration ($2017)	Prepared By:	R. Doyle/J. Yan/M. Wong
		Checked By:	G. Hermanson/E. Roy
Estimate Type:	Planning	Check Date:	26-Sep-17

Sunnyoaks Facilities									
18", PVC, 8' Cover	18	in-dia	1,180	LF	$	334	$	394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	3%		1	LS	$	11,820	$	12,000	Up to 8' of cover
Potholing			12	EA	$	3,600	$	42,000	Light Urban, $3,600 per 100 feet of pipe
30", MLCSP, 12' Cover	30	in-dia	120	LF	$	430	$	52,000	Full lane AC, bell and spigot installation, 100% import. 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$	2,600	$	3,000	9' to 14' of cover
Potholing			1	EA	$	6,000	$	7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$	8,579	$	17,000	Rs Means
12" Meter	12	in-dia	1	EA	$	15,000	$	15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$	25,000	$	25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	RS Means
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$	10,000	$	10,000	regrading, etc Engineer's estimate
Budd Ave Facilities									
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$	477	$	778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$	38,900	$	39,000	9' to 14' of cover
Potholing			16	EA	$	3,600	$	59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$	18,055	$	36,000	Rs Means
30" BFV	30	in-dia	2	EA	$	22,000	$	44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$	20,000	$	20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$	40,000	$	40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$	8	$	1,000	RS Means
Vault Box			1	EA	$	10,116	$	10,000	
Vault Shoring			236	SF	$	13	$	3,000	RS Means
Vault Dewatering			3	MTH	$	59,000	$	177,000	
Concrete Wallsfor Discharge Structure			11	CY	$	1,000	$	11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$	800	$	2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$	133	$	2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$	10,000	$	10,000	regrading, etc Engineer's estimate

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

	Kirk Ditch Facilities							
	36", MLCSP, 12' Cover	36	in-dia	40	Allow	$ 545	$ 22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 1,100	$ 1,000	9' to 14' of cover
	Potholing			0	EA	$ 1,200	$ -	Rural, $1,200 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate
16 - Electrical							$ 60,000	
	Electrical Allowance			4	EA	$15,000	$ 60,000	Engineers Estimate
17 - I&C							$ 40,000	
	I&C Allowance			4	EA	$10,000	$ 40,000	Engineers Estimate
ANNUAL O&M COSTS				Quantity	Unit	Value	Cost	Notes
Consumables							$ 10,000	
	Mechanical			2%		$487,000	$ 10,000	2% of Valves and Meters
Labor Costs							$ 315,000	
	Pond Maintenance			68	AC	$4,531	$ 307,000	Engineer's estimate
	Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year			47	HR	$175	$ 8,000	Engineer's estimate
						TOTAL ANNUAL O&M COSTS	**$ 325,000**	

Portfolio 4 cost estimate details

Table 36. Separate Regional AWPF in Palo Alto; 14 mgd for GWR (Portfolio 4)

Focus: Cost Summary
Aspect: AWPF (1 of 2)
Capacity: 14 mgd
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**87,000,000**
Contingency - Treatment Facility	25%	$	22,000,000
Construction Cost Subtotal		**$**	**109,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	17,000,000
Estimated Total Construction Cost		**$**	**131,000,000**
Owner's Reserve for Change Orders	15%	$	20,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	20,000,000
Construction Management	13%	$	18,000,000
Engineering Services During Construction	12%	$	16,000,000
Total Capital Cost		**$**	**205,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,440,000
Energy/Power	$	3,200,000
Chemicals	$	1,680,000
Labor	$	2,100,000
Total Annual O&M Cost	**$**	**8,420,000**

Replacement and Renewal Costs		
100-yr Lifecycle (present value, $2019)	$	111,000,000
30-yr Lifecycle (present value, $2019)	$	48,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	10,460,000
Annual O&M Cost		$	8,420,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	1,600,000
Total Annual Cost		**$**	**18,880,000**
Annual Yield	**AF***		**10,571**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**1,790**

*proportional distribution of Palo Alto and Sunnyvale based on 18,500 AF modeled yield

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	7,887,700	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	5,667,500	7%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	453,200	1%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	604,200	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	2,647,600	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	10,590,300	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,755,100	4%
Division 32 – Exterior Improvements	$	111,200	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	10,837,200	12%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	12,798,900	15%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	31,411,700	36%
TOTAL	**$**	**87,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF (1 of 2)
Capacity: 14 mgd
Location: Palo Alto

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		35,528	CY		$ 11.78			$ 418,600	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,143	CY		$ 58.49			$ 651,800	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		15,533	SY		$ 4.63			$ 72,000	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, sewer connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 1,166,667	24 Mgd is $2,000,000, scaled down	$ 1,166,700	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		1,414	SF		$ 141.20		Assumes (2) 30' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 199,700	Inter Process Tank
Division 31 – Earthwork	Sitework	10-inch Waste Pipeline		1,200	LF			$ 324.94	10-inch, HDPE, 11' Cover	$ 390,000	Unit cost was obtained by interpolating using available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 390,000	9' to 14' of cover	$ 19,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,259	CY		$ 645		See Site Work and Concrete	$ 812,300	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		630	CY		$ 1,150		See Site Work and Concrete	$ 724,100	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		660	CY		$ 1,090		See Site Work and Concrete	$ 719,400	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		135	CY		$ 645		See Site Work and Concrete	$ 86,800	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		127	CY		$ 645		See Site Work and Concrete	$ 81,700	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		41	CY		$ 645		See Site Work and Concrete	$ 26,400	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		379	CY		$ 645		See Site Work and Concrete	$ 244,700	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		3,259	CY		$ 645		See Site Work and Concrete	$ 2,102,100	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		30	CY		$ 645		See Site Work and Concrete	$ 19,200	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		27	CY		$ 645		See Site Work and Concrete	$ 17,200	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		53	CY		$ 645		See Site Work and Concrete	$ 34,400	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		150	CY		$ 1,090		See Site Work and Concrete	$ 163,500	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		20	CY		$ 645		See Site Work and Concrete	$ 12,700	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 52.94			$ 111,200	

Focus: Cost Inputs and R&R
Aspect: AWPF (1 of 2)
Capacity: 14 mgd
Location: Palo Alto

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$453,125	Engineer's Estimate	$ 453,200	Scaled from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$604,167	Engineer's Estimate	$ 604,200	Scaled from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	6	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 285,300	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 5,745,539			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 5,745,600	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	10,000	1				$70,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 70,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	100	5	EA	$ 47,545				$ 237,800	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 16,434,000			October 2019 Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 16,434,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	3	EA	$ 29,364				$ 88,100	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			scaled 5/4/17 proposal from Daniel Mechanical includes (3) decarbonator towers, flow distributor system, media, fan system down by one unit	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	3	EA	$ 35,424				$ 106,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 5,088,790			1 duty, 1 standby 14 mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 5,088,800	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	3	EA	$ 37,950				$ 113,900	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		44,000	SF		$ 218.58		220' x 200'; furnished and installed	$ 9,617,500	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.50	EA		$ 534,375		Need two tanks (approx 95,000 gallons each) assume 1/2 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 267,200	Storage Tanks

Focus: Cost Inputs and R&R
Aspect: AWPF (1 of 2)
Capacity: 14 mgd
Location: Palo Alto

Date: 11/9/2020
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Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 2,129,167			Scaled down from DN Tanks cost proposal, need one 2.3 MG tank	$ 2,129,200	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC costs (linear interpolation; unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$31,411,700	30% of Equipment Costs	$ 9,423,600	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$9,423,600	5% of Piping Allowance	$ 471,200	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$9,423,600	5% of Piping Allowance	$ 471,200	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$9,423,600	5% of Piping Allowance	$ 471,200	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$31,411,700	30% of Equipment Costs	$ 9,423,600	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$10,590,300	25% of Electrical Costs	$ 2,647,600	
O&M	Consumables	UF Membranes Replacement		450	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 891,200	
O&M	Consumables	RO Membranes Replacement		554	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 192,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		245	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 48,100	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		34	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 26,700	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 996,100	2% of Pumping Equipment Cost	$ 20,000	
O&M	Consumables	Electrical Consumables		2%	% of			$ 10,590,300	2% of Electrical Cost	$ 211,900	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,647,600	2% of Instrumentation & Controls Cost	$ 53,000	
O&M	Power	Influent Pumps		3,267,480	kWh		$ 0.10			$ 338,100	
O&M	Power	UF Air Scour		4,555	kWh		$ 0.10			$ 500	
O&M	Power	UF CIP		5,957	kWh		$ 0.10			$ 700	
O&M	Power	RO Transfer Pumps		3,267,480	kWh		$ 0.10			$ 338,100	
O&M	Power	RO Feed Pumps		19,604,880	kWh		$ 0.10			$ 2,028,200	
O&M	Power	RO Inter-Stage Pumps		392,098	kWh		$ 0.10			$ 40,600	
O&M	Power	RO CIP		1,417	kWh		$ 0.10			$ 200	

Focus:	Cost Inputs and R&R
Aspect:	AWPF (1 of 2)
Capacity:	14 mgd
Location:	Palo Alto

Date:	11/9/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B Adjusted Unit	Cost Method C Project Specific	Cost Method C: Assumptions	Cost Total	Notes
O&M	Power	Decarbonator Feed Pumps		490,122	kWh		$ 0.10			$ 50,800	
O&M	Power	Decarbonator Blowers		392,098	kWh		$ 0.10			$ 40,600	
O&M	Power	UV/AOP Transfer Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	UV System		1,909,680	kWh		$ 0.10			$ 197,600	
O&M	Power	RO Concentrate Waste Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	Waste Equalization Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		30,100	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 67,800	scaled down from 24 mgd flow
O&M	Chemicals	Aq. Ammonia		18,083	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 1,800	scaled down from 24 mgd flow
O&M	Chemicals	Citric Acid		2,100	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 11,700	scaled down from 24 mgd flow
O&M	Chemicals	Hydrogen Peroxide		35,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 179,900	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hydroxide		56,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 161,500	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hypochlorite		1,233,167	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 752,300	scaled down from 24 mgd flow
O&M	Chemicals	Lime		511,715	lb		$ 0.15		based on 12 mg/L dose	$ 76,700	
O&M	Chemicals	Sulfuric Acid		15,680	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 15,700	scaled down from 24 mgd flow
O&M	Chemicals	RO Antiscalant		15,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 316,700	scaled down from 24 mgd flow
O&M	Chemicals	RO Low pH Cleaner		11,900	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 66,300	scaled down from 24 mgd flow
O&M	Chemicals	RO High pH Cleaner		11,900	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 34,400	scaled down from 24 mgd flow
O&M	Labor	Water Plant Operator		4,160	hours/yr		$ 163.20			$ 679,000	Assumes two plant operators 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Sr Mechanics		4,160	hours/yr		$ 172.27			$ 716,700	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 37. Separate Regional AWPF in Sunnyvale; 10 mgd for GWR, 0.5 mgd for NPR+ (Portfolio 4)

Focus: Cost Summary
Element: AWPF (2 of 2)
Capacity: 10.5 MGD
Location: Sunnyvale

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**72,000,000**
Contingency - Treatment Facility	25%	$	18,000,000
Construction Cost Subtotal		**$**	**90,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	14,000,000
Estimated Total Construction Cost		**$**	**109,000,000**
Owner's Reserve for Change Orders	15%	$	17,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	17,000,000
Construction Management	13%	$	15,000,000
Engineering Services During Construction	12%	$	14,000,000
Total Capital Cost		**$**	**172,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,160,000
Energy/Power	$	2,580,000
Chemicals	$	1,260,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**6,400,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	93,000,000
30-yr Lifecycle (present value, $2019)	$	40,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	8,780,000
Annual O&M Cost		$	6,400,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	1,333,333
Total Annual Cost		**$**	**16,513,333**
Annual Yield	**AF**		**7,929**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,090**

*proportional distribution of Palo Alto and Sunnyvale based on 18,500 AF modeled yield

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	6,524,100	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	4,456,800	6%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	328,200	0%
Division 06 – Woods, Plastics, and Composites	$	-	0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	437,500	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$	-	0%
Division 12 – Furnishings	$	-	0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	2,188,100	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	8,752,400	12%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	3,656,900	5%
Division 32 – Exterior Improvements	$	130,300	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	9,059,100	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	9,973,400	14%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	26,257,800	36%
TOTAL	**$**	**72,000,000**	

Focus: Cost Inputs and R&R
Element: AWPF (2 of 2)
Capacity: 10.5 MGD
Location: Sunnyvale

Date: 11/9/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$65,240,500	10% of Divisions 2-47	$ 6,524,100	
Division 31 – Earthwork	Sitework	Site Clear and Grub		8	Acre		$ 7,760			$ 64,100	
Division 31 – Earthwork	Sitework	Excavation		40,373	CY		$ 11.78			$ 475,600	
Division 31 – Earthwork	Sitework	Site Specific Site Prep. for Recycle Hill		1	LS			See Note		See Note	Site-specific prep work for Recycle Hill included in costs at the portfolio level (See App A-1, Table D-11). Based on estimate prepared by City of Sunnyvale staff in 2016. The original estimate was rounded up to $40 million and escalated to 2019 dollars. This cost is not subject to construction markup/escalation factors.
Division 31 – Earthwork	Sitework	Compaction		19,965	CY		$ 0.89			$ 17,800	
Division 31 – Earthwork	Sitework	Grading		39,930	SY		$ 1.18			$ 47,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		13,857	CY		$ 58.49			$ 810,500	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800	
Division 31 – Earthwork	Sitework	Gravel		16,063.89	SY		$ 4.63			$ 74,400	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 179,539		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 179,600	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,075,269			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,075,300	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, sewer connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 875,000	24 mgd plant is $2,000,000, scaled down	$ 875,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		1,232	SF		$ 141.20		Assumes (2) 28' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 173,900	Inter Process Tank
Division 31 – Earthwork	Sitework	10-inch Waste Pipeline		500	LF			$ 324.94	10-inch, HDPE, 11' Cover	$ 162,500	Unit cost was obtained by interpolating using available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 162,500	9' to 14' of cover	$ 8,200	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		5	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 6,200	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,037	CY		$ 645		See Site Work and Concrete	$ 668,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		519	CY		$ 1,150		See Site Work and Concrete	$ 596,300	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		587	CY		$ 1,090		See Site Work and Concrete	$ 639,500	EQ Basin
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		119	CY		$ 645		See Site Work and Concrete	$ 76,900	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		107	CY		$ 645		See Site Work and Concrete	$ 68,800	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		26	CY		$ 645		See Site Work and Concrete	$ 17,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		252	CY		$ 645		See Site Work and Concrete	$ 162,500	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		407	CY		$ 645		See Site Work and Concrete	$ 262,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		46	CY		$ 1,090		See Site Work and Concrete	$ 50,700	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		2,607	CY		$ 645		See Site Work and Concrete	$ 1,681,600	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		30	CY		$ 645		See Site Work and Concrete	$ 19,200	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		27	CY		$ 645		See Site Work and Concrete	$ 17,200	Electrical

Focus: Cost Inputs and R&R
Element: AWPF (2 of 2)
Capacity: 10.5 MGD
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Prepared by: R. Guillen
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		57	CY		$ 645		See Site Work and Concrete	$ 36,700	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		112	CY		$ 1,090		See Site Work and Concrete	$ 122,100	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,460	LF		$ 52.94			$ 130,300	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 328,125	Engineer's Estimate	$ 328,200	Scaled from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 437,500	Engineer's Estimate	$ 437,500	Scaled from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	5	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 237,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,596,431			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,596,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	10,000	1				$70,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 70,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	100	5	EA	$ 47,545				$ 237,800	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,695,000			October 2019 Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,695,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			scaled 5/4/17 proposal from Daniel Mechanical includes (2) decarbonator towers, flow distributor system, media, fan system down by one unit	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,003,456			1 duty, 1 standby 14 mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,003,500	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	3	4	EA	$ 11,385				$ 45,600	Additional Pumping Requirements

Focus: Cost Inputs and R&R
Element: AWPF (2 of 2)
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		35,200	SF		$ 219		220' x 160'; furnished and installed	$ 7,694,000	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 83,000 gallons each) assume 2/5 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 213,800	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 1,596,875			Scaled down from DN Tanks cost proposal, need one 1.75 MG tank	$ 1,596,900	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 26,257,800	30% of Equipment Costs	$ 7,877,400	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 7,877,400	5% of Piping Allowance	$ 393,900	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 7,877,400	5% of Piping Allowance	$ 393,900	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 7,877,400	5% of Piping Allowance	$ 393,900	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 26,257,800	30% of Equipment Costs	$ 7,877,400	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 8,752,400	25% of Electrical Costs	$ 2,188,100	
O&M	Consumables	UF Membranes Replacement		360	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 712,900	
O&M	Consumables	RO Membranes Replacement		462	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 160,400	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		140	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 27,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 863,100	2% of Pumping Equipment Cost	$ 17,300	
O&M	Consumables	Electrical Consumables		2%	% of			$ 8,752,400	2% of Electrical Cost	$ 175,100	

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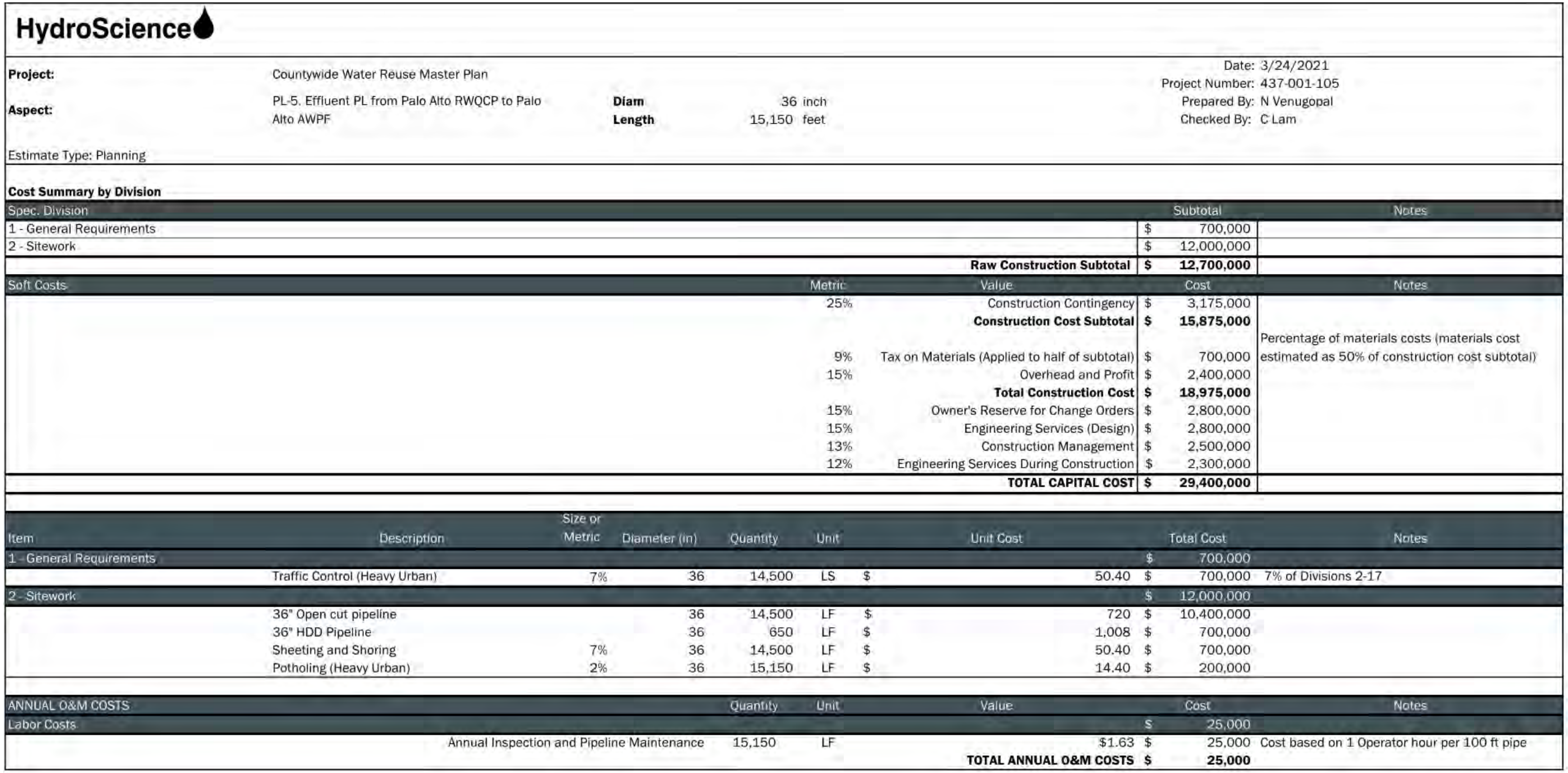
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,188,100	2% of Instrumentation & Controls Cost	$ 43,800	
O&M	Power	Influent Pumps		2,613,984	kWh		$ 0.10			$ 270,500	
O&M	Power	UF Air Scour		4,555	kWh		$ 0.10			$ 500	
O&M	Power	UF CIP		5,957	kWh		$ 0.10			$ 700	
O&M	Power	RO Transfer Pumps		2,613,984	kWh		$ 0.10			$ 270,500	
O&M	Power	RO Feed Pumps		16,337,400	kWh		$ 0.10			$ 1,690,200	
O&M	Power	RO Inter-Stage Pumps		326,748	kWh		$ 0.10			$ 33,900	
O&M	Power	RO CIP		1,181	kWh		$ 0.10			$ 200	
O&M	Power	Decarbonator Feed Pumps		326,748	kWh		$ 0.10			$ 33,900	
O&M	Power	Decarbonator Blowers		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	UV/AOP Transfer Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	UV System		1,462,920	kWh		$ 0.10			$ 151,400	
O&M	Power	RO Concentrate Waste Pumps		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	Waste Equalization Pumps		39,210	kWh		$ 0.10			$ 4,100	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Sodium Bisulfite		22,575	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 50,800	scaled down from 24 mgd flow
O&M	Chemicals	Aq. Ammonia		13,563	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 1,400	scaled down from 24 mgd flow
O&M	Chemicals	Citric Acid		1,575	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 8,800	scaled down from 24 mgd flow
O&M	Chemicals	Hydrogen Peroxide		26,250	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 134,900	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hydroxide		42,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 121,100	scaled down from 24 mgd flow
O&M	Chemicals	Sodium Hypochlorite		924,875	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 564,200	scaled down from 24 mgd flow
O&M	Chemicals	Lime		383,787	lb		$ 0.15		based on 12 mg/L dose	$ 57,600	
O&M	Chemicals	Sulfuric Acid		11,760	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 11,800	scaled down from 24 mgd flow
O&M	Chemicals	RO Antiscalant		11,550	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 237,600	scaled down from 24 mgd flow
O&M	Chemicals	RO Low pH Cleaner		8,925	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 49,800	scaled down from 24 mgd flow
O&M	Chemicals	RO High pH Cleaner		8,925	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 25,800	scaled down from 24 mgd flow
O&M	Labor	Water Plant Operator		2080	hours/yr		$ 163			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Sr Mechanics		2080	hours/yr		$ 172			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Control Tech II		2080	hours/yr		$ 172			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2080	hours/yr		$ 167			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 38. PL-5, 36-inch effluent pipeline from Palo Alto RWQCP to Palo Alto AWPF (Portfolio 4)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF	**Diam**	36 inch	Prepared By:	N Venugopal
		Length	15,150 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 700,000	
2 - Sitework	$ 12,000,000	
Raw Construction Subtotal	**$ 12,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,175,000	
		Construction Cost Subtotal	**$ 15,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,400,000	
		Total Construction Cost	**$ 18,975,000**	
	15%	Owner's Reserve for Change Orders	$ 2,800,000	
	15%	Engineering Services (Design)	$ 2,800,000	
	13%	Construction Management	$ 2,500,000	
	12%	Engineering Services During Construction	$ 2,300,000	
		TOTAL CAPITAL COST	**$ 29,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 700,000	
	Traffic Control (Heavy Urban)	7%	36	14,500	LS	$ 50.40	$ 700,000	7% of Divisions 2-17
2 - Sitework							$ 12,000,000	
	36" Open cut pipeline		36	14,500	LF	$ 720	$ 10,400,000	
	36" HDD Pipeline		36	650	LF	$ 1,008	$ 700,000	
	Sheeting and Shoring	7%	36	14,500	LF	$ 50.40	$ 700,000	
	Potholing (Heavy Urban)	2%	36	15,150	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 25,000	
Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$ 25,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 25,000**	

Table 39. PL-10, 36-inch purified water pipeline from Palo Alto AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-10. Purified water PL, Palo Alto AWPF to Joint Purified Water PL	**Diam**	36 inch	Prepared By:	N Venugopal
		Length	34,500 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,700,000	
2 - Sitework	$ 27,300,000	
Raw Construction Subtotal	**$ 29,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 7,250,000	
		Construction Cost Subtotal	**$ 36,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 5,400,000	
		Total Construction Cost	**$ 43,250,000**	
	15%	Owner's Reserve for Change Orders	$ 6,500,000	
	15%	Engineering Services (Design)	$ 6,500,000	
	13%	Construction Management	$ 5,600,000	
	12%	Engineering Services During Construction	$ 5,200,000	
		TOTAL CAPITAL COST	**$ 67,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 1,700,000	
	Traffic Control (Heavy Urban)	7%	36	33,650	LS	$ 50.40	$ 1,700,000	7% of Divisions 2-17
2 - Sitework							$ 27,300,000	
	36" Open cut pipeline		36	33,650	LF	$ 720	$ 24,200,000	
	36" HDD Pipeline		36	850	LF	$ 1,008	$ 900,000	
	Sheeting and Shoring	7%	36	33,650	LF	$ 50.40	$ 1,700,000	
	Potholing (Heavy Urban)	2%	36	34,500	LF	$ 14.40	$ 500,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 56,000	
	Annual Inspection and Pipeline Maintenance	34,500	LF	$1.63	$ 56,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 56,000**	

Table 40. PL-11, 48-inch purified water pipeline from Joint Purified Water Pipeline to LGRP (Portfolio 4)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-11. Joint Purified Water PL (at Arques) to LGRP	**Diam**	48 inch	Prepared By:	N Venugopal
		Length	72,500 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 4,700,000	
2 - Sitework		$ 80,800,000	
	Raw Construction Subtotal	**$ 85,500,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 21,375,000	
		Construction Cost Subtotal	**$ 106,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 4,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 16,000,000	
		Total Construction Cost	**$ 127,675,000**	
	15%	Owner's Reserve for Change Orders	$ 19,200,000	
	15%	Engineering Services (Design)	$ 19,200,000	
	13%	Construction Management	$ 16,600,000	
	12%	Engineering Services During Construction	$ 15,300,000	
		TOTAL CAPITAL COST	**$ 198,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 4,700,000	
	Traffic Control (Heavy Urban)	7%	48	70,350	LS	$ 67.20	$ 4,700,000	7% of Divisions 2-17
2 - Sitework							$ 80,800,000	
	48" Open cut pipeline		48	70,350	LF	$ 960	$ 67,500,000	
	48" Microtunnel Pipeline & Casing		48	2,150	LF	$ 3,360	$ 7,200,000	
	Sheeting and Shoring	7%	48	70,350	LF	$ 67.20	$ 4,700,000	
	Potholing (Heavy Urban)	2%	48	72,500	LF	$ 19.20	$ 1,400,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 118,000	
	Annual Inspection and Pipeline Maintenance	72,500	LF	$1.63	$ 118,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 118,000**	

Table 41. PL-12, 36-inch purified water pipeline from Sunnyvale AWPF to mid-point connecting to Joint Purified Water Pipeline (Portfolio 4)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PL-12. Purified water PL, Sunnyvale to Joint Purified Water PL	**Diam**	36 inch	Prepared By:	N Venugopal
		Length	11,400 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 500,000	
2 - Sitework			$ 9,200,000	
		Raw Construction Subtotal	**$ 9,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,425,000	
		Construction Cost Subtotal	**$ 12,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,800,000	
		Total Construction Cost	**$ 14,425,000**	
	15%	Owner's Reserve for Change Orders	$ 2,200,000	
	15%	Engineering Services (Design)	$ 2,200,000	
	13%	Construction Management	$ 1,900,000	
	12%	Engineering Services During Construction	$ 1,700,000	
		TOTAL CAPITAL COST	**$ 22,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 500,000	
	Traffic Control (Heavy Urban)	7%	36	10,550	LS	$ 50.40	$ 500,000	7% of Divisions 2-17
2 - Sitework							$ 9,200,000	
	36" Open cut pipeline		36	10,550	LF	$ 720	$ 7,600,000	
	36" HDD Pipeline		36	850	LF	$ 1,008	$ 900,000	
	Sheeting and Shoring	7%	36	10,550	LF	$ 50.40	$ 500,000	
	Potholing (Heavy Urban)	2%	36	11,400	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 19,000	
Annual Inspection and Pipeline Maintenance	11,400	LF	$1.63	$ 19,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 19,000**	

Table 42. PS-3, pump station to convey Palo Alto RWQCP effluent to Palo Alto AWPF (Portfolio 4)

HydroScience

Project:	**Countywide Water Reuse Master Plan**				Date: 3/24/2021 Project Number: 437-001-105
Aspect:	**PS-3. Effluent from PA RWQCP to PA AWPF**	**Flow**	**12,000**	**gpm**	Prepared By: N Venugopal
		TDH	**100**	**feet**	Checked By: C Lam
		Horsepower	**508**	**hp**	

Estimate Type: Planning

Cost Summary by Division

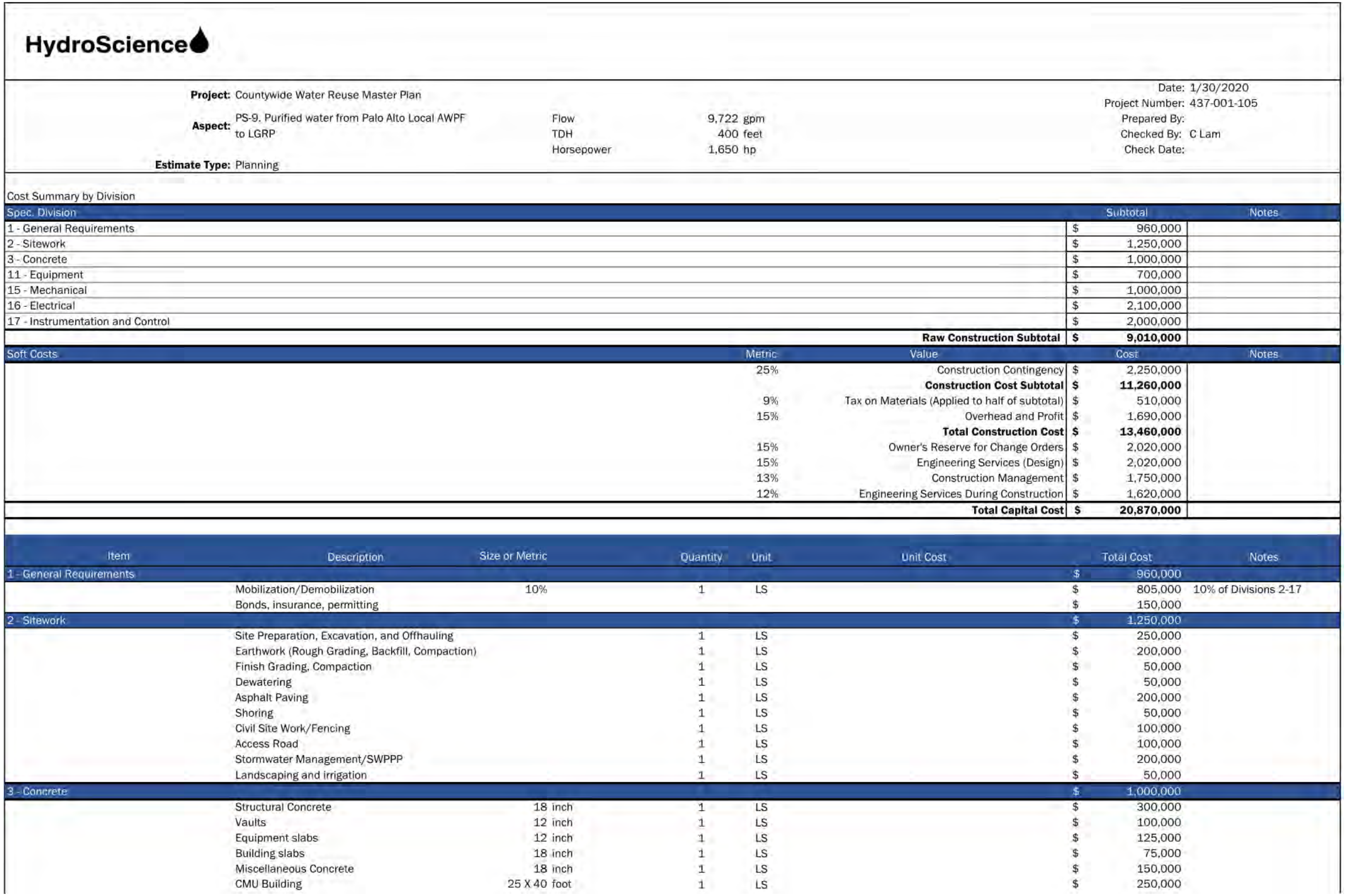
Spec. Division		Subtotal	Notes
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**260,000**	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	100,000	
2 - Sitework						**$**	**290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
3 - Concrete						**$**	**250,000**	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	60,000	
	Equipment slabs	12 inch	1	LS		$	40,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 425,000**	
	Pump		1	LS		$ 250,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
	Standby generator		1	LS			
17 - I&C						**$ 300,000**	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 22,000**	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						**$ 567,000**	
	Electricity Requirement	508 hp	2,986,139	kWh	$0.19	$ 567,000	
					TOTAL ANNUAL O&M COSTS	**$ 589,000**	

Table 43. PS-9, pump station to convey Palo Alto AWPF purified water to LGRP (Portfolio 4)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-9. Purified water from Palo Alto Local AWPF to LGRP
Estimate Type: Planning

Flow 9,722 gpm
TDH 400 feet
Horsepower 1,650 hp

Date: 1/30/2020
Project Number: 437-001-105
Prepared By:
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	960,000	
2 - Sitework	$	1,250,000	
3 - Concrete	$	1,000,000	
11 - Equipment	$	700,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	2,100,000	
17 - Instrumentation and Control	$	2,000,000	
Raw Construction Subtotal	**$**	**9,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,250,000	
		Construction Cost Subtotal	**$**	**11,260,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	510,000	
	15%	Overhead and Profit	$	1,690,000	
		Total Construction Cost	**$**	**13,460,000**	
	15%	Owner's Reserve for Change Orders	$	2,020,000	
	15%	Engineering Services (Design)	$	2,020,000	
	13%	Construction Management	$	1,750,000	
	12%	Engineering Services During Construction	$	1,620,000	
		Total Capital Cost	**$**	**20,870,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	960,000	
	Mobilization/Demobilization	10%	1	LS		$	805,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						$	1,250,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	200,000	
	Landscaping and irrigation		1	LS		$	50,000	
3 - Concrete						$	1,000,000	
	Structural Concrete	18 inch	1	LS		$	300,000	
	Vaults	12 inch	1	LS		$	100,000	
	Equipment slabs	12 inch	1	LS		$	125,000	
	Building slabs	18 inch	1	LS		$	75,000	
	Miscellaneous Concrete	18 inch	1	LS		$	150,000	
	CMU Building	25 X 40 foot	1	LS		$	250,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 700,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 500,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 125,000	
15 - Mechanical						$ 1,000,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						$ 2,100,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
	Standby generator		1	LS		$ 600,000	
17 - I&C						$ 2,000,000	
	I&C/SCADA/Programming Allowance					$ 2,000,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 116,000	
	Equipment		2%		$700,000	$ 14,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$2,100,000	$ 42,000	2% of Division 16
	Instrumentation		2%		$2,000,000	$ 40,000	2% of Division 17
Power Costs						$ 1,552,000	
	Electricity Requirement	1,650 hp	9,699,073	kWh	$0.16	$ 1,552,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,668,000**	

Table 44. PS-10, pump station to convey Sunnyvale AWPF purified water to LGRP (Portfolio 4)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/24/2021
				Project Number:	437-001-105
Aspect:	PS-10. Purified water from Sunnyvale AWPF to LGRP	Flow	6,945 gpm	Prepared By:	
		TDH	400 feet	Checked By:	C Lam
		Horsepower	1,200 hp	Check Date:	
Estimate Type:	Planning				

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	880,000	
2 - Sitework	$	1,250,000	
3 - Concrete	$	950,000	
11 - Equipment	$	650,000	
15 - Mechanical	$	800,000	
16 - Electrical	$	1,800,000	
17 - Instrumentation and Control	$	1,800,000	
Raw Construction Subtotal	**$**	**8,130,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,030,000	
		Construction Cost Subtotal	**$**	**10,160,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	460,000	
	15%	Overhead and Profit	$	1,520,000	
		Total Construction Cost	**$**	**12,140,000**	
	15%	Owner's Reserve for Change Orders	$	1,820,000	
	15%	Engineering Services (Design)	$	1,820,000	
	13%	Construction Management	$	1,580,000	
	12%	Engineering Services During Construction	$	1,460,000	
		Total Capital Cost	**$**	**18,820,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	880,000	
	Mobilization/Demobilization	10%	1	LS		$	725,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						$	1,250,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	200,000	
	Landscaping and irrigation		1	LS		$	50,000	
3 - Concrete						$	950,000	
	Structural Concrete	18 inch	1	LS		$	300,000	
	Vaults	12 inch	1	LS		$	100,000	
	Equipment slabs	12 inch	1	LS		$	125,000	
	Building slabs	18 inch	1	LS		$	75,000	
	Miscellaneous Concrete	18 inch	1	LS		$	150,000	
	CMU Building	25 X 40 foot	1	LS		$	200,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
11 - Equipment						$ 650,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 450,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 125,000	
15 - Mechanical						$ 800,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 600,000	
16 - Electrical						$ 1,800,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,300,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						$ 1,800,000	
	I&C/SCADA/Programming Allowance					$ 1,800,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 101,000	
	Equipment		2%		$650,000	$ 13,000	2% of Division 11
	Mechanical		2%		$800,000	$ 16,000	2% of Division 15
	Electrical		2%		$1,800,000	$ 36,000	2% of Division 16
	Instrumentation		2%		$1,800,000	$ 36,000	2% of Division 17
Power Costs						$ 1,129,000	
	Electricity Requirement	1,200 hp	7,053,872	kWh	$0.16	$ 1,129,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,230,000**	

Table 45. LGRP site improvements (Portfolio 4)

Divisions		2019 Estimate (Escalated to $2019) Los Gatos Pond - Baseline Configuration ($2019)
1 - General		$ 595,000
2 - Site Work		$ 4,148,000
3 - Concrete		$ -
5 - Metals		$ -
10 - Specialties		$ -
11 - Equipment		$ -
10 - Specialties		$ -
13 - Special Construction		$ -
14 - Conveying Systems		$ -
15 - Mechanical		$ -
16 - Electrical/Instrumentation		$ 62,000
17 - Instrumentation & Controls		$ 41,000
Subtotal[1]		**$ 4,800,000**
Construction Contingency	15%	$ 724,000
Construction Cost Subtotal		**$ 5,500,000**
Tax on Materials (Applied to half of subtotal)	9%	$ 257,000
Overhead and Profit	15%	$ 832,000
Total Construction Cost		**$ 6,600,000**
Owner's Reserve for Change Orders	15%	$ 1,002,000
Environmental Documentation and Permits	0%	$ -
Engineering Services (Design)	15%	$ 1,002,000
Construction Management	13%	$ 873,000
Engineering Services During Construction	12%	$ 801,000
Total Capital Cost		**$ 11,000,000**
		$ -
O&M Costs		O&M Costs
Consumables (Equipment, Mechanical, Electrical, I&C)		$ 10,000
Labor		$ 329,000
Total O&M		**$ 339,000**

1. Subtotal rounded to nearest hundred thousand

RMC water and environment

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Process Cost Summary by Division

Spec. Division	Subtotal (2017 $)	Notes
1 - General Requirements	$ 579,000	
2 - Sitework	$ 4,037,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 40,000	
Subtotal	**$ 4,716,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost (2017 $)	Notes
1 - General Requirements							$ 579,000	
	Mobilization	10%		1	LS	$413,700	$ 414,000	10% of Divisions 2-17
	Traffic Control	4%		1	LS	$165,480	$ 165,000	Assumed average traffic control was light urban
2 - Sitework							$ 4,037,000	
	Page Pond Facilities							
	36", MLCSP, 12' Cover	36	in-dia	1,800	LF	$ 545	$ 980,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$ 49,000	$ 49,000	9' to 14' of cover
	Potholing			18	EA	$ 6,000	$ 108,000	Heavy Urban, $6,000 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$ 25,000	$ 25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$ 60,000	$ 60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$ 80,000	$ 80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$ 8	$ 1,000	RS Means
	Vault Box			1	EA	$ 10,116	$ 10,000	
	Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
	Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$ 1,000	$ 13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$ 800	$ 4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$ 133	$ 3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$ 25,000	$ 25,000	regrading, etc Engineer's estimate

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

Sunnyoaks Facilities							
18", PVC, 8' Cover	18	in-dia	1,180	LF	$ 334	$ 394,000	100 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	3%		1	LS	$ 11,820	$ 12,000	Up to 8' of cover
Potholing			12	EA	$ 3,600	$ 42,000	Light Urban, $3,600 per 100 feet of pipe
30", MLCSP, 12' Cover	30	in-dia	120	LF	$ 430	$ 52,000	Full lane AC, bell and spigot installation, 100% import. 50 ft per day production
Sheeting and Shoring (Open Cut)	5%		1	LS	$ 2,600	$ 3,000	9' to 14' of cover
Potholing			1	EA	$ 6,000	$ 7,000	Heavy Urban, $6,000 per 100 feet of pipe
18" BFV	18	in-dia	2	EA	$ 8,579	$ 17,000	Rs Means
12" Meter	12	in-dia	1	EA	$ 15,000	$ 15,000	Engineer's estimate
12" FCV	12	in-dia	1	EA	$ 25,000	$ 25,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$ 8	$ 1,000	RS Means
Vault Box			1	EA	$ 10,116	$ 10,000	RS Means
Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
Concrete Wallsfor Discharge Structure			11	CY	$ 1,000	$ 11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$ 800	$ 2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$ 133	$ 2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
Canal / Embankment Modifications			1	LS	$ 10,000	$ 10,000	regrading, etc Engineer's estimate
Budd Ave Facilities							
24", MLCSP, 12' Cover	24	in-dia	1,630	LF	$ 477	$ 778,000	80 ft/d production, Full lane AC, bell and spigot installation, 100% import
Sheeting and Shoring (Open Cut)	5%		1	LS	$ 38,900	$ 39,000	9' to 14' of cover
Potholing			16	EA	$ 3,600	$ 59,000	Light Urban, $3,600 per 100 feet of pipe
24" BFV	24	in-dia	2	EA	$ 18,055	$ 36,000	Rs Means
30" BFV	30	in-dia	2	EA	$ 22,000	$ 44,000	Engineer's estimate
18" Meter	18	in-dia	1	EA	$ 20,000	$ 20,000	Engineer's estimate
18" FCV	18	in-dia	1	EA	$ 40,000	$ 40,000	Vendor estimate
Excavation for Discharge Structure and Vault Box			88	CY	$ 8	$ 1,000	RS Means
Vault Box			1	EA	$ 10,116	$ 10,000	
Vault Shoring			236	SF	$ 13	$ 3,000	RS Means
Vault Dewatering			3	MTH	$ 59,000	$ 177,000	
Concrete Wallsfor Discharge Structure			11	CY	$ 1,000	$ 11,000	RMC, 2017 (August 2017)
Concrete Slab for Discharge Structure			3	CY	$ 800	$ 2,000	RMC, 2017 (August 2017)
Rip Rap / Apron			13	CY	$ 133	$ 2,000	RS Means
Misc. Facilities (Handrails, fencing, etc)			1	LS	$ 15,000	$ 15,000	Engineer's estimate
Canal / Embankment Modifications			1	Allow	$ 10,000	$ 10,000	regrading, etc Engineer's estimate

Project: SCVWD Purified Water Program Preliminary Engineering Services

Aspect: Los Gatos Pond - Baseline Configuration ($2017)

Estimate Type: Planning

Date: 7-Sep-17
Project Number: 0027-016
Prepared By: R. Doyle/J. Yan/M. Wong
Checked By: G. Hermanson/E. Roy
Check Date: 26-Sep-17

	Kirk Ditch Facilities									
	36", MLCSP, 12' Cover	36	in-dia	40	Allow	$	545	$	22,000	Full lane AC, bell and spigot installation, 100% import, 50 ft per day production
	Sheeting and Shoring (Open Cut)	5%		1	LS	$	1,100	$	1,000	9' to 14' of cover
	Potholing			0	EA	$	1,200	$	-	Rural, $1,200 per 100 feet of pipe
	36" BFV	36	in-dia	1	EA	$	25,000	$	25,000	Engineer's estimate
	30" Meter	30	in-dia	1	EA	$	60,000	$	60,000	Engineer's estimate
	30" FCV	30	in-dia	1	EA	$	80,000	$	80,000	Vendor estimate
	Excavation for Discharge Structure and Vault Box			114	CY	$	8	$	1,000	RS Means
	Vault Box			1	EA	$	10,116	$	10,000	
	Vault Shoring			236	SF	$	13	$	3,000	RS Means
	Vault Dewatering			3	MTH	$	59,000	$	177,000	
	Concrete Wallsfor Discharge Structure			13	CY	$	1,000	$	13,000	RMC, 2017 (August 2017)
	Concrete Slab for Discharge Structure			5	CY	$	800	$	4,000	RMC, 2017 (August 2017)
	Rip Rap / Apron			20	CY	$	133	$	3,000	RS Means
	Misc. Facilities (Handrails, fencing, etc)			1	LS	$	15,000	$	15,000	Engineer's estimate
	Canal / Embankment Modifications			1	Allow	$	25,000	$	25,000	regrading, etc Engineer's estimate
16 - Electrical								$	60,000	
	Electrical Allowance			4	EA		$15,000	$	60,000	Engineers Estimate
17 - I&C								$	40,000	
	I&C Allowance			4	EA		$10,000	$	40,000	Engineers Estimate

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Consumables					$	10,000	
	Mechanical	2%		$487,000	$	10,000	2% of Valves and Meters
Labor Costs					$	315,000	
	Pond Maintenance	68	AC	$4,531	$	307,000	Engineer's estimate
	Annual Inspection and Maintenance of Pipeline - Average Annual Operator Hours per Year	47	HR	$175	$	8,000	Engineer's estimate
				TOTAL ANNUAL O&M COSTS	**$**	**325,000**	

Morgan Hill options cost estimate details

Table 46. PL-35, 16-inch NPR+ pipeline from Metcalf Energy Center to Burnett Road at Monterey (Morgan Hill Option 1)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-35: Metcalf to Burnett

Diam 16 inch
Length 31500 feet

Estimate Type: Planning

Date: 10/22/2019
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 700,000	
2 - Sitework	$ 11,050,000	
Raw Construction Subtotal	**$ 12,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,000,000	
		Construction Cost Subtotal	**$ 15,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 680,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,250,000	
		Total Construction Cost	**$ 17,930,000**	
	15%	Owner's Reserve for Change Orders	$ 2,690,000	
	15%	Engineering Services (Design)	$ 2,690,000	
	13%	Construction Management	$ 2,330,000	
	12%	Engineering Services During Construction	$ 2,150,000	
		Total Capital Cost	**$ 28,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 700,000	
	Traffic Control (Heavy Urban)	7%	16	31,350	LS	$ 22.40	$ 700,000	7% of Divisions 2-17
2 - Sitework							$ 11,050,000	
	16" Open cut pipeline		16	31,350	LF	$ 320	$ 10,030,000	
	16" Bore and Jack Pipeline & Casing		16	150	LF	$ 832	$ 120,000	
	Sheeting and Shoring	7%	16	31,350	LF	$ 22.40	$ 700,000	
	Potholing (Heavy Urban)	2%	16	31,500	LF	$ 6.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 51,408	
Annual Inspection and Pipeline Maintenance	31,500	LF	$1.63	$ 51,408	
			TOTAL ANNUAL O&M COSTS	**$ 51,000**	

Table 47. Satellite WWTP and AWPF, 2.5 mgd for GWR (Morgan Hill Option 2)

Focus: Cost Summary
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Note

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**24,000,000**
Contingency - Treatment Facility	25%	$	6,000,000
Construction Cost Subtotal		**$**	**30,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	2,000,000
General Contractor Overhead and Profit	15%	$	5,000,000
Estimated Total Construction Cost		**$**	**37,000,000**
Owner's Reserve for Change Orders	15%	$	6,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	6,000,000
Construction Management	13%	$	5,000,000
Engineering Services During Construction	12%	$	5,000,000
Total Capital Cost		**$**	**59,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	710,000
Energy/Power	$	1,020,000
Chemicals	$	2,770,000
Labor	$	2,080,000
Total Annual O&M Cost	**$**	**6,580,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	35,000,000
30-yr Lifecycle (present value, $2019)	$	16,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	3,010,000
Annual O&M Cost		$	6,580,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	530,000
Total Annual Cost		**$**	**10,120,000**
Annual Yield	**AF**		**2,350**
Unit Cost ($/AF)		**$**	**4,310**

Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	2,217,800	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	1,886,800	8%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	200,000	1%
Division 06 – Woods, Plastics, and Composites	$		0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	250,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$		0%
Division 12 – Furnishings	$		0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	823,400	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	3,293,300	14%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	1,025,500	4%
Division 32 – Exterior Improvements	$	70,700	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	3,212,400	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	2,104,800	9%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	9,310,700	39%
TOTAL	**$**	**24,000,000**	

Brown and Caldwell

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date:	2/10/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	M. Tsuruda
Checked By:	D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$22,177,600	10% of Divisions 2-47	$ 2,217,800	
Division 31 – Earthwork	Sitework	Site Clear and Grub		3	Acre		$ 7,760			$ 19,900	
Division 31 – Earthwork	Sitework	Strip Topsoil		12,358	SY		$ 0.85			$ 10,600	
Division 31 – Earthwork	Sitework	Backfill Haul to Site		3,389	CY		$ 8.88			$ 30,100	
Division 31 – Earthwork	Sitework	Fill Placement		3,389	CY		$ 1.04			$ 3,600	
Division 31 – Earthwork	Sitework	Excavation		8,638	CY		$ 11.78			$ 101,800	
Division 31 – Earthwork	Sitework	Compaction		7,509	CY		$ 0.89			$ 6,700	
Division 31 – Earthwork	Sitework	Grading		12,358	SY		$ 1.18			$ 14,600	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		1	LS			$ 25,000		$ 25,000	
Division 31 – Earthwork	Sitework	Offhaul Allowance		1	LS			$ 75,000	Engineer's Estimate	$ 75,000	
Division 31 – Earthwork	Sitework	Aggregate Base		4,119	CY		$ 58.49			$ 241,000	
Division 31 – Earthwork	Sitework	Asphalt		637	CY		$ 2.01			$ 1,300	
Division 31 – Earthwork	Sitework	Gravel		1,479	CY		$ 4.63			$ 6,900	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 50,000		$ 50,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 56,000		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 56,000	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 333,000			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 333,000	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, phone connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 500,000	Engineer's estimate	$ 500,000	
Division 03 – Concrete	Concrete	Headworks Slab		144	CY		$ 645		Slab 65'x35',10" thick	$ 92,900	
Division 03 – Concrete	Concrete	Valve Vault Slab		10	CY		$ 645		Slab 13' x 12' x 2' thick	$ 6,300	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Valve Vault Walls		13	CY		$ 1,090		Walls 5' high, 8" thick	$ 14,000	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Slab		14	CY		$ 645		Slab 16' x 12' x 2' thick	$ 9,200	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		31	CY		$ 1,090		Walls 10' high, 8" thick	$ 34,000	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	EQ Basin Slab		197	CY		$ 645		Slab 31' x 86' x 2' thick	$ 127,400	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		74	CY		$ 1,150		Suspended Slab 25' x 80' x 1' thick	$ 85,200	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		312	CY		$ 1,090		Walls 24' depth, 8" thick	$ 340,100	EQ Basin
Division 03 – Concrete	Concrete	MBR Walls		41	CY		$ 645		Walls 4.7' high, 8" thick	$ 26,800	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Blowers Slab Area		124	CY		$ 1,090		Slab 12' x 60' x 2' thick	$ 135,700	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Membrane Slab Area		557	CY		$ 645		Slab area = 3500 ft ^2	$ 359,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		68	CY		$ 645		Slab 23' x 10' x 2' thick	$ 44,000	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Slab		43	CY		$ 645		Slab 24' x 24' x 2' thick	$ 27,600	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Walls		11	CY		$ 1,090		Walls 24' high, 8" thick	$ 12,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		19	CY		$ 645		Slab 10' x 25' x 2' thick	$ 12,000	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		44	CY		$ 645		Slab 20' x 30' x 2' thick	$ 28,700	Treatment Equipment

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		123	CY		$ 645		Slabs areas = 1658 ft^2, 2' thick	$ 79,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		27	CY		$ 1,090		Walls 4.7' high, 8" thick	$ 28,900	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		555	CY		$ 645		Slab 70' x 107', 2' thick	$ 358,000	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		18	CY		$ 645		Slab 20' x 12', 2' thick	$ 11,500	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		17	CY		$ 645		Slab 15' x 15', 2' thick	$ 10,800	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 03 – Concrete	Concrete	RO Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		1,334	LF		$ 52.94			$ 70,700	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 200,000	Engineer's Estimate	$ 200,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 250,000	Engineer's Estimate	$ 250,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	MBR System		1	LS	$ 3,028,125			Proposal for a 2 MGD system, includes: MBR,RAS Pumps, Filtrate and Air Headers,Filtrate Pumping System, Chemical System, Blowers, Air system, Manufacturing services, plus 25% to account for extra 0.5 mgd	$ 3,028,200	
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	6,000	1				$ 42,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 42,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	2	2	EA			$ 7,500		$ 15,000	Cost from Des
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 3,441,464			Revised 9/22/17 Proposal from Wigen includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 3,441,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA			$ 50,000	Estimated based on costs from Des	$ 200,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 375,000			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 375,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 3,000				$ 12,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 1,345,500			Based on packaged quote from Wedeco. See notes for what this package assumes	$ 1,345,500	Package includes reactors, instrumentation control automation,ballasts, instrumentation, chemical feed/static mixing system, field services(does not include installation so used this quote)
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 329,070			Package includes one (1) Bulk Bag Unloading system with High Density Slurry Batching and Metering System	$ 329,100	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	2	EA	$ 8,625				$ 17,300	Assumed same as feed pumps
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		7,490	SF		$ 218.58		245' x 345'; furnished and installed	$ 1,637,200	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 55,000 gallons		1	EA		$ -	$ 60,000	(1) 55,000 steel tanks, assumes 30 minutes of feed to the RO system at ultimate flows	$ 60,000	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 319,375			Scaled down from DN Tanks cost proposal, need one 0.4 MG tank	$ 319,400	Prestressed Concrete Tank
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,658	SF	$ 47			Quantity = chemical area	$ 78,300	Canopy
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 2,615			Assumes 30 day storage	$ 2,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 4,500			Assumes 30 day storage	$ 4,500	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 9,310,700	30% of Equipment Costs	$ 2,793,300	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 9,310,700	30% of Equipment Costs	$ 2,793,300	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 3,293,300	25% of Electrical Costs	$ 823,400	
O&M	Consumables	MBR Membranes Replacement		270	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 534,700	
O&M	Consumables	RO Membranes Replacement		196	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 68,100	Installation costs covered by O&M labor
O&M	Consumables	UV Lamp Replacement		42	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 8,300	Installation costs covered by O&M labor

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	UV Ballast Replacement		7	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 5,800	Installation costs covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 694,300	2% of Pumping Equipment Cost	$ 13,900	
O&M	Consumables	Electrical Consumables		2%	% of			$ 3,293,300	2% of Electrical Cost	$ 65,900	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 823,400	2% of Instrumentation & Controls Cost	$ 16,500	
O&M	Power	Influent Pumps		98,024	kWh		$ 0.10			$ 10,200	
O&M	Power	RO Transfer Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	RO Feed Pumps		6,534,960	kWh		$ 0.10			$ 676,100	
O&M	Power	Decarbonator Feed Pumps		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	Decarbonator Blowers		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV/AOP Transfer Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	UV System		402,960	kWh		$ 0.10			$ 41,700	
O&M	Power	RO Concentrate Waste Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		6,535	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 700	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25			$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10			$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57			$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14			$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88			$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Dosing 8ppm for 2ppm chloramine residual on secondary effluent through RO; 2ppm residual in purified water for transmission	$ 1,289,600	
O&M	Chemicals	Lime		91,378	lb		$ 0.15		based on 12 mg/L dose	$ 13,700	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00			$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56			$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57			$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88			$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	
O&M	Labor	Sr Mechanics		2,080	hours/yr		$ 172.27			$ 358,400	
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	

Table 48. PS-13, pump station to convey Morgan Hill AWPF purified water to San Pedro Recharge Ponds (Morgan Hill Option 2)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS 13 - Morgan Hill AWPF to San Pedro Ponds

Estimate Type: Planning

Flow	1,458	gpm
TDH	125	feet
Horsepower	78	hp

Date: 10/15/2019
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 60,000	
2 - Sitework	$ 110,000	
3 - Concrete	$ 80,000	
11 - Equipment	$ 65,000	
15 - Mechanical	$ 25,000	
16 - Electrical	$ 60,000	
17 - Instrumentation and Control	$ 60,000	
Raw Construction Subtotal	**$ 460,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 115,000	
		Construction Cost Subtotal	**$ 575,000**	
	15%	Overhead and Profit	$ 100,000	
		Total Construction Cost	**$ 675,000**	
	15%	Owner's Reserve for Change Orders	$ 100,000	
	15%	Engineering Services (Design)	$ 100,000	
	13%	Construction Management	$ 90,000	
	12%	Engineering Services During Construction	$ 100,000	
		Total Capital Cost	**$ 1,065,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 60,000	
	Mobilization/Demobilization	10%	1	LS		$ 40,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 20,000	
2 - Sitework						$ 110,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 15,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 25,000	
	Finish Grading, Compaction		1	LS		$ 15,000	
	Asphalt Paving		1	LS		$ 10,000	
	Shoring		1	LS		$ 10,000	
	Civil Site Work/Fencing		1	LS		$ 10,000	
	Access Road		1	LS		$ 10,000	
	Landscaping and irrigation		1	LS		$ 15,000	
3 - Concrete						$ 80,000	
	Structural Concrete	18 inch	1	LS		$ 40,000	
	Vaults	12 inch	1	LS		$ 20,000	
	Equipment slabs	12 inch	1	LS		$ 20,000	
11 - Equipment						$ 65,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 50,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 15,000	

15 - Mechanical						$ 25,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 25,000	
16 - Electrical						$ 60,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 60,000	
	Standby generator		1	LS			Power from AWTF
17 - I&C						$ 60,000	
	I&C/SCADA/Programming Allowance					$ 60,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 4,200	
	Equipment		2%		$65,000	$ 1,300	2% of Division 11
	Mechanical		2%		$25,000	$ 500	2% of Division 15
	Electrical		2%		$60,000	$ 1,200	2% of Division 16
	Instrumentation		2%		$60,000	$ 1,200	2% of Division 17
Power Costs						$ 73,325	
	Electricity Requirement	78 hp	458,281	kWh	$0.16	$ 73,325	
					TOTAL ANNUAL O&M COSTS	**$ 77,525**	

Table 49. PL-25, 16-inch purified water pipeline from Morgan Hill AWPF to San Pedro Recharge Ponds (Morgan Hill Option 2)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-25: Morgan Hill AWPF to San Pedro

Diam 16 inch
Length 14600 feet

Estimate Type: Planning

Date: 2/10/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 320,000	
2 - Sitework		$ 5,340,000	
	Raw Construction Subtotal	**$ 5,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,425,000	
		Construction Cost Subtotal	**$ 7,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 320,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,070,000	
		Total Construction Cost	**$ 8,515,000**	
	15%	Owner's Reserve for Change Orders	$ 1,280,000	
	15%	Engineering Services (Design)	$ 1,280,000	
	13%	Construction Management	$ 1,110,000	
	12%	Engineering Services During Construction	$ 1,020,000	
		Total Capital Cost	**$ 13,200,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 320,000	
	Traffic Control (Heavy Urban)	7%	16	14,100	LS	$ 22.40	$ 320,000	7% of Divisions 2-17
2 - Sitework							$ 5,340,000	
	16" Open cut pipeline		16	14,100	LF	$ 320	$ 4,510,000	
	16" Bore and Jack Pipeline & Casing		16	500	LF	$ 832	$ 420,000	
	Sheeting and Shoring	7%	16	14,100	LF	$ 22.40	$ 320,000	
	Potholing (Heavy Urban)	2%	16	14,600	LF	$ 6.40	$ 90,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 23,827	
	Annual Inspection and Pipeline Maintenance	14,600	LF	$1.63	$ 23,827	
				TOTAL ANNUAL O&M COSTS	**$ 24,000**	

Table 50. Satellite WWTP and AWPF, 2.5 mgd for SWA (Morgan Hill Option 3)

Brown AND Caldwell

Focus: Cost Summary
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Note

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**24,000,000**
Contingency - Treatment Facility	25%	$	6,000,000
Construction Cost Subtotal		**$**	**30,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	2,000,000
General Contractor Overhead and Profit	15%	$	5,000,000
Estimated Total Construction Cost		**$**	**37,000,000**
Owner's Reserve for Change Orders	15%	$	6,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	6,000,000
Construction Management	13%	$	5,000,000
Engineering Services During Construction	12%	$	5,000,000
Total Capital Cost		**$**	**59,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	710,000
Energy/Power	$	1,020,000
Chemicals	$	2,770,000
Labor	$	2,080,000
Total Annual O&M Cost	**$**	**6,580,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	35,000,000
30-yr Lifecycle (present value, $2019)	$	16,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	3,010,000
Annual O&M Cost		$	6,580,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	530,000
Total Annual Cost		**$**	**10,120,000**
Annual Yield	**AF**		**2,350**
Unit Cost ($/AF)		**$**	**4,310**

Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 – General Requirements	$	2,217,800	9%
Division 02 – Site Construction	$	-	0%
Division 03 – Concrete	$	1,886,800	8%
Division 04 – Masonry	$	-	0%
Division 05 – Metals	$	200,000	1%
Division 06 – Woods, Plastics, and Composites	$		0%
Division 07 – Thermal and Moisture Protection	$	-	0%
Division 08 – Doors and Windows	$	-	0%
Division 09 – Finishes	$	250,000	1%
Division 10 – Specialties	$	-	0%
Division 11 – Equipment	$		0%
Division 12 – Furnishings	$		0%
Division 13 – Special Construction	$	-	0%
Division 14 – Conveying Systems	$	-	0%
Division 15 – Mechanical	$	-	0%
Division 17 – Instrumentation	$	823,400	3%
Division 21 – Fire Suppression	$	-	0%
Division 22 – Plumbing	$	-	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 – Electrical	$	3,293,300	14%
Division 27 – Communications	$	-	0%
Division 28 – Electronic Safety and Security	$	-	0%
Division 31 – Earthwork	$	1,025,500	4%
Division 32 – Exterior Improvements	$	70,700	0%
Division 33 – Utilities	$	-	0%
Division 40 – Process Integration	$	3,212,400	13%
Division 41 – Material Processing and Handling Equipment	$	-	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$	2,104,800	9%
Division 44 – Pollution and Waste Control Equipment	$	-	0%
Division 46 – Water and Wastewater Equipment	$	9,310,700	39%
TOTAL	**$**	**24,000,000**	

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$22,177,600	10% of Divisions 2-47	$ 2,217,800	
Division 31 – Earthwork	Sitework	Site Clear and Grub		3	Acre		$ 7,760			$ 19,900	
Division 31 – Earthwork	Sitework	Strip Topsoil		12,358	SY		$ 0.85			$ 10,600	
Division 31 – Earthwork	Sitework	Backfill Haul to Site		3,389	CY		$ 8.88			$ 30,100	
Division 31 – Earthwork	Sitework	Fill Placement		3,389	CY		$ 1.04			$ 3,600	
Division 31 – Earthwork	Sitework	Excavation		8,638	CY		$ 11.78			$ 101,800	
Division 31 – Earthwork	Sitework	Compaction		7,509	CY		$ 0.89			$ 6,700	
Division 31 – Earthwork	Sitework	Grading		12,358	SY		$ 1.18			$ 14,600	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		1	LS			$ 25,000		$ 25,000	
Division 31 – Earthwork	Sitework	Offhaul Allowance		1	LS			$ 75,000	Engineer's Estimate	$ 75,000	
Division 31 – Earthwork	Sitework	Aggregate Base		4,119	CY		$ 58.49			$ 241,000	
Division 31 – Earthwork	Sitework	Asphalt		637	CY		$ 2.01			$ 1,300	
Division 31 – Earthwork	Sitework	Gravel		1,479	CY		$ 4.63			$ 6,900	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 50,000		$ 50,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 56,000		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 56,000	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 333,000			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 333,000	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 50,000	Engineer's estimate for water, internet, phone connections	$ 50,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 500,000	Engineer's estimate	$ 500,000	
Division 03 – Concrete	Concrete	Headworks Slab		144	CY		$ 645		Slab 65'x35',10" thick	$ 92,900	
Division 03 – Concrete	Concrete	Valve Vault Slab		10	CY		$ 645		Slab 13' x 12' x 2' thick	$ 6,300	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Valve Vault Walls		13	CY		$ 1,090		Walls 5' high, 8" thick	$ 14,000	Diversion Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Slab		14	CY		$ 645		Slab 16' x 12' x 2' thick	$ 9,200	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	Influent Wetwell Walls		31	CY		$ 1,090		Walls 10' high, 8" thick	$ 34,000	Influent Wetwell & Pump Station
Division 03 – Concrete	Concrete	EQ Basin Slab		197	CY		$ 645		Slab 31' x 86' x 2' thick	$ 127,400	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		74	CY		$ 1,150		Suspended Slab 25' x 80' x 1' thick	$ 85,200	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		312	CY		$ 1,090		Walls 24' depth, 8" thick	$ 340,100	EQ Basin
Division 03 – Concrete	Concrete	MBR Walls		41	CY		$ 645		Walls 4.7' high, 8" thick	$ 26,800	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Blowers Slab Area		124	CY		$ 1,090		Slab 12' x 60' x 2' thick	$ 135,700	Treatment Equipment
Division 03 – Concrete	Concrete	MBR Membrane Slab Area		557	CY		$ 645		Slab area = 3500 ft ^2	$ 359,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		68	CY		$ 645		Slab 23' x 10' x 2' thick	$ 44,000	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Slab		43	CY		$ 645		Slab 24' x 24' x 2' thick	$ 27,600	Treatment Equipment
Division 03 – Concrete	Concrete	RO CIP Area Walls		11	CY		$ 1,090		Walls 24' high, 8" thick	$ 12,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		19	CY		$ 645		Slab 10' x 25' x 2' thick	$ 12,000	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		44	CY		$ 645		Slab 20' x 30' x 2' thick	$ 28,700	Treatment Equipment

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		123	CY		$ 645		Slabs areas = 1658 ft^2, 2' thick	$ 79,300	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		27	CY		$ 1,090		Walls 4.7' high, 8" thick	$ 28,900	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		555	CY		$ 645		Slab 70' x 107', 2' thick	$ 358,000	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		18	CY		$ 645		Slab 20' x 12', 2' thick	$ 11,500	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		17	CY		$ 645		Slab 15' x 15', 2' thick	$ 10,800	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 03 – Concrete	Concrete	RO Waste Equalization Wetwell Manhole		1	CY		$ 21,430		5' diam, 8' deep	$ 21,500	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		1,334	LF		$ 52.94			$ 70,700	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 200,000	Engineer's Estimate	$ 200,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 250,000	Engineer's Estimate	$ 250,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	MBR System		1	LS	$ 3,028,125			Proposal for a 2 MGD system, includes: MBR,RAS Pumps, Filtrate and Air Headers,Filtrate Pumping System, Chemical System, Blowers, Air system, Manufacturing services, plus 25% to account for extra 0.5 mgd	$ 3,028,200	
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	6,000	1				$ 42,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 42,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	2	2	EA			$ 7,500		$ 15,000	Cost from Des
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 3,441,464			Revised 9/22/17 Proposal from Wigen includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 3,441,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA			$ 50,000	Estimated based on costs from Des	$ 200,000	
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 375,000			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 375,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 3,000				$ 12,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 1,345,500			Based on packaged quote from Wedeco. See notes for what this package assumes	$ 1,345,500	Package includes reactors, instrumentation control automation,ballasts, instrumentation, chemical feed/static mixing system, field services(does not include installation so used this quote)
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 329,070			Package includes one (1) Bulk Bag Unloading system with High Density Slurry Batching and Metering System	$ 329,100	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

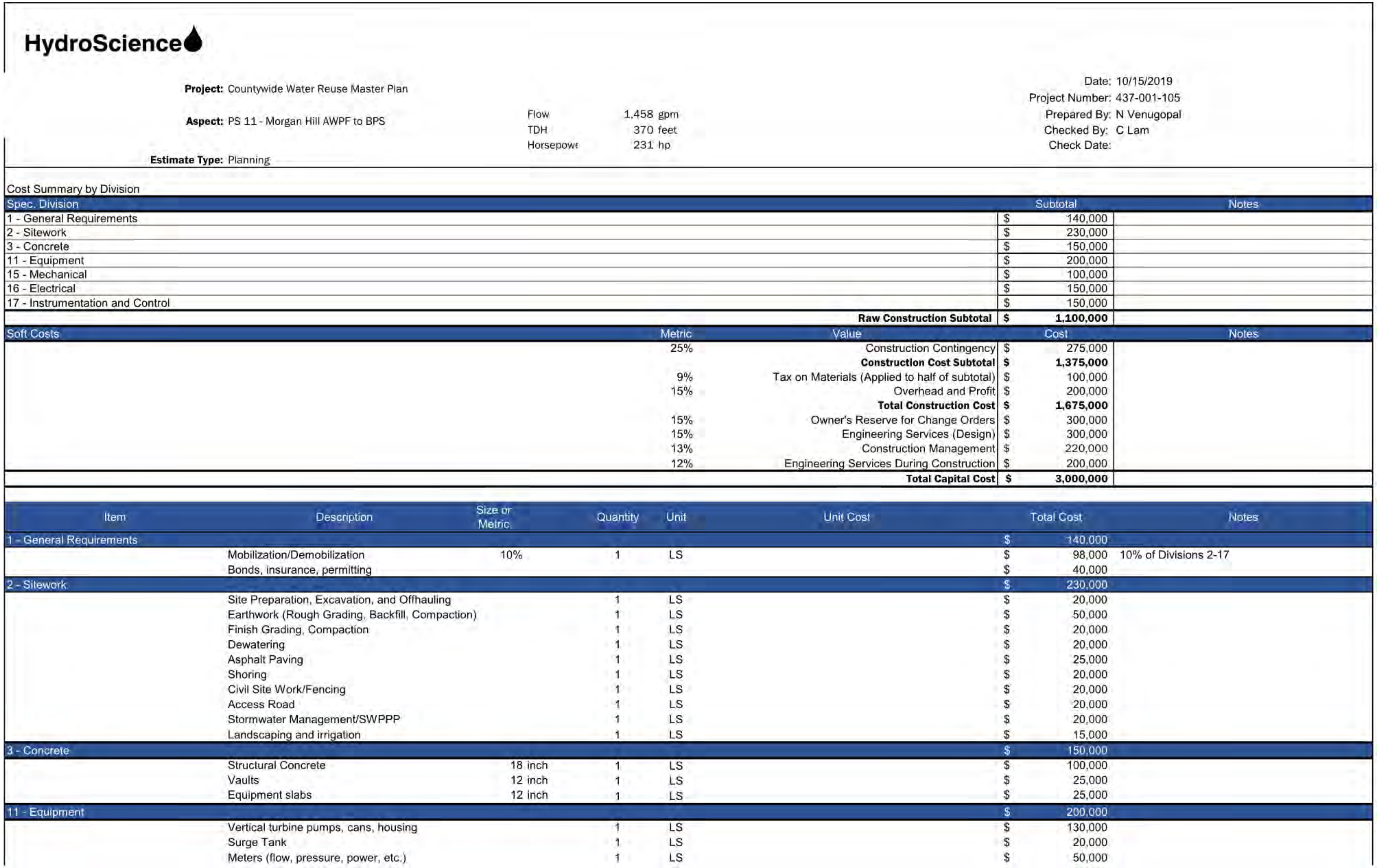
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 - Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	2	EA	$ 8,625				$ 17,300	Assumed same as feed pumps
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		7,490	SF		$ 218.58		245' x 345'; furnished and installed	$ 1,637,200	Process Building
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 55,000 gallons		1	EA		$ -	$ 60,000	(1) 55,000 steel tanks, assumes 30 minutes of feed to the RO system at ultimate flows	$ 60,000	Storage Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 319,375			Scaled down from DN Tanks cost proposal, need one 0.4 MG tank	$ 319,400	Prestressed Concrete Tank
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,658	SF	$ 47			Quantity = chemical area	$ 78,300	Canopy
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 2,615			Assumes 30 day storage	$ 2,700	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 4,500			Assumes 30 day storage	$ 4,500	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 888			Assumes 30 day storage	$ 900	Chemical Tanks
Division 40 - Process Integration	Mechanical	Piping allowance		30%	% of			$ 9,310,700	30% of Equipment Costs	$ 2,793,300	
Division 40 - Process Integration	Mechanical	Valve allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 40 - Process Integration	Mechanical	Fitting allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 40 - Process Integration	Mechanical	Supports allowance		5%	% of			$ 2,793,300	5% of Piping Allowance	$ 139,700	
Division 26 - Electrical	Electrical	Electrical Allowance		30%	% of			$ 9,310,700	30% of Equipment Costs	$ 2,793,300	
Division 17 - Instrumentation	I&C	I&C Allowance		25%	% of			$ 3,293,300	25% of Electrical Costs	$ 823,400	
O&M	Consumables	MBR Membranes Replacement		270	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 534,700	
O&M	Consumables	RO Membranes Replacement		196	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 68,100	Installation costs covered by O&M labor
O&M	Consumables	UV Lamp Replacement		42	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 8,300	Installation costs covered by O&M labor

Focus: Cost Inputs and R&R
Element: Morgan Hill Satellite WWTP and AWPF
Capacity: 2.5 mgd
Location: Morgan Hill

Date: 2/10/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: M. Tsuruda
Checked By: D. Gellerman

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Consumables	UV Ballast Replacement		7	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 5,800	Installation costs covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 694,300	2% of Pumping Equipment Cost	$ 13,900	
O&M	Consumables	Electrical Consumables		2%	% of			$ 3,293,300	2% of Electrical Cost	$ 65,900	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 823,400	2% of Instrumentation & Controls Cost	$ 16,500	
O&M	Power	Influent Pumps		98,024	kWh		$ 0.10			$ 10,200	
O&M	Power	RO Transfer Pumps		784,195	kWh		$ 0.10			$ 81,200	
O&M	Power	RO Feed Pumps		6,534,960	kWh		$ 0.10			$ 676,100	
O&M	Power	Decarbonator Feed Pumps		261,398	kWh		$ 0.10			$ 27,100	
O&M	Power	Decarbonator Blowers		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV/AOP Transfer Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	UV System		402,960	kWh		$ 0.10			$ 41,700	
O&M	Power	RO Concentrate Waste Pumps		130,699	kWh		$ 0.10			$ 13,600	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		6,535	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 700	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25			$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10			$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57			$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14			$ 308,300	
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88			$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Dosing 8ppm for 2ppm chloramine residual on secondary effluent through RO; 2ppm residual in purified water for transmission	$ 1,289,600	
O&M	Chemicals	Lime		91,378	lb		$ 0.15		based on 12 mg/L dose	$ 13,700	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00			$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56			$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57			$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88			$ 58,900	
O&M	Labor	Water Plant Operator		6,240	hours/yr		$ 163.20			$ 1,018,400	
O&M	Labor	Sr Mechanics		2,080	hours/yr		$ 172.27			$ 358,400	
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	

Table 51. PS-11, pump station to convey Morgan Hill AWPF purified water to the booster pump station (Morgan Hill Option 3)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS 11 - Morgan Hill AWPF to BPS

Estimate Type: Planning

Flow 1,458 gpm
TDH 370 feet
Horsepowe 231 hp

Date: 10/15/2019
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	140,000	
2 - Sitework	$	230,000	
3 - Concrete	$	150,000	
11 - Equipment	$	200,000	
15 - Mechanical	$	100,000	
16 - Electrical	$	150,000	
17 - Instrumentation and Control	$	150,000	
Raw Construction Subtotal	**$**	**1,100,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	275,000	
		Construction Cost Subtotal	**$**	**1,375,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	100,000	
	15%	Overhead and Profit	$	200,000	
		Total Construction Cost	**$**	**1,675,000**	
	15%	Owner's Reserve for Change Orders	$	300,000	
	15%	Engineering Services (Design)	$	300,000	
	13%	Construction Management	$	220,000	
	12%	Engineering Services During Construction	$	200,000	
		Total Capital Cost	**$**	**3,000,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	140,000	
	Mobilization/Demobilization	10%	1	LS		$	98,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	40,000	
2 - Sitework						$	230,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	20,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	20,000	
	Dewatering		1	LS		$	20,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	20,000	
	Civil Site Work/Fencing		1	LS		$	20,000	
	Access Road		1	LS		$	20,000	
	Stormwater Management/SWPPP		1	LS		$	20,000	
	Landscaping and irrigation		1	LS		$	15,000	
3 - Concrete						$	150,000	
	Structural Concrete	18 inch	1	LS		$	100,000	
	Vaults	12 inch	1	LS		$	25,000	
	Equipment slabs	12 inch	1	LS		$	25,000	
11 - Equipment						$	200,000	
	Vertical turbine pumps, cans, housing		1	LS		$	130,000	
	Surge Tank		1	LS		$	20,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	50,000	

15 - Mechanical						$ 100,000	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 50,000	
16 - Electrical						$ 150,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 150,000	
	Standby generator		1	LS			Power from AWTF
17 - I&C						$ 150,000	
	I&C/SCADA/Programming Allowance					$ 150,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 12,000	
	Equipment		2%		$200,000	$ 4,000	2% of Division 11
	Mechanical		2%		$100,000	$ 2,000	2% of Division 15
	Electrical		2%		$150,000	$ 3,000	2% of Division 16
	Instrumentation		2%		$150,000	$ 3,000	2% of Division 17
Power Costs						$ 217,259	
	Electricity Requirement	231 hp	1,357,870	kWh	$0.16	$ 217,259	
					TOTAL ANNUAL O&M COSTS	**$ 229,000**	

Table 52. PS-12, pump station to convey purified water from the booster pump station to Anderson Reservoir (Morgan Hill Option 3)

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS 12 - BPS to Anderson Reservoir (Morgan Hill)

Estimate Type: Planning

Flow	1,458	gpm
TDH	350	feet
Horsepower	218	hp

Date: 10/15/2019
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

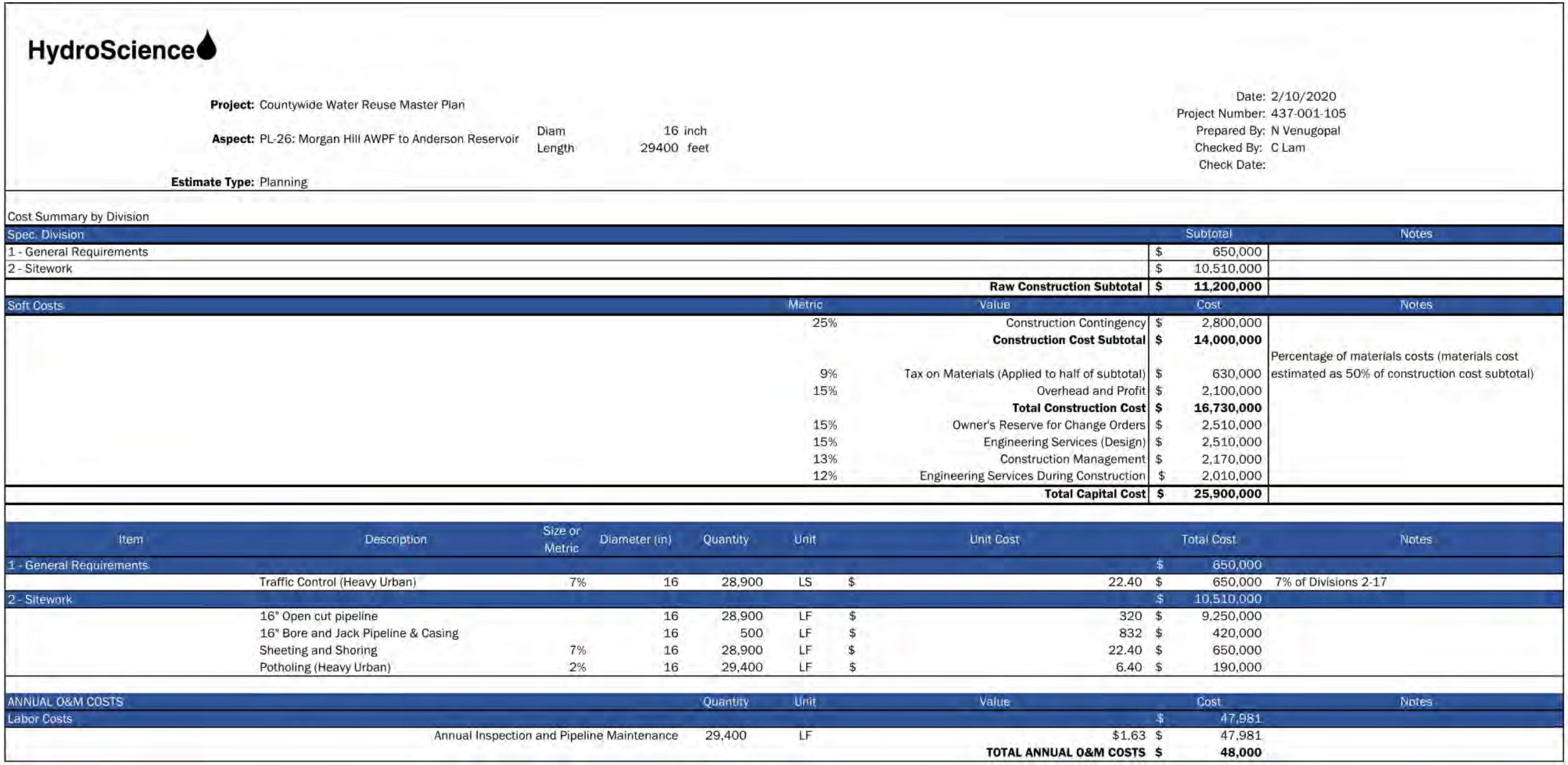
Spec. Division		Subtotal	Notes
1 - General Requirements	$	100,000	
2 - Sitework	$	200,000	
3 - Concrete	$	100,000	
11 - Equipment	$	70,000	
15 - Mechanical	$	30,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	150,000	
Raw Construction Subtotal	**$**	**900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	225,000	
		Construction Cost Subtotal	**$**	**1,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	100,000	
	15%	Overhead and Profit	$	200,000	
		Total Construction Cost	**$**	**1,425,000**	
	15%	Owner's Reserve for Change Orders	$	200,000	
	15%	Engineering Services (Design)	$	200,000	
	13%	Construction Management	$	190,000	
	12%	Engineering Services During Construction	$	200,000	
		Total Capital Cost	**$**	**2,000,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	100,000	
	Mobilization/Demobilization	10%	1	LS		$	80,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	25,000	
2 - Sitework						$	200,000	
	Site Preparation, Excavation, and Offhauling		1	LS		$	20,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	20,000	
	Asphalt Paving		1	LS		$	15,000	
	Shoring		1	LS		$	20,000	
	Civil Site Work/Fencing		1	LS		$	20,000	
	Access Road		1	LS		$	10,000	
	Landscaping and irrigation		1	LS		$	15,000	

3 - Concrete						$ 100,000	
	Structural Concrete	18 inch	1	LS		$ 40,000	
	Vaults	12 inch	1	LS		$ 25,000	
	Equipment slabs	12 inch	1	LS		$ 25,000	
11 - Equipment						$ 70,000	
	Vertical turbine pumps, cans, housing		1	LS		$ 10,000	
	Surge Tank		1	LS		$ 20,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 40,000	
15 - Mechanical						$ 30,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 30,000	
16 - Electrical						$ 250,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 150,000	
	Standby generator		1	LS		$ 100,000	
17 - I&C						$ 150,000	
	I&C/SCADA/Programming Allowance					$ 150,000	
ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						$ 10,000	
	Equipment		2%		$70,000	$ 1,400	2% of Division 11
	Mechanical		2%		$30,000	$ 600	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$150,000	$ 3,000	2% of Division 17
Power Costs						$ 205,310	
	Electricity Requirement	218 hp	1,283,188	kWh	$0.16	$ 205,310	
					TOTAL ANNUAL O&M COSTS	**$ 215,310**	

Table 53. PL-26, 16-inch purified water pipeline from Morgan Hill AWPF to Anderson Reservoir (Morgan Hill Option 3)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-26: Morgan Hill AWPF to Anderson Reservoir

Diam 16 inch
Length 29400 feet

Estimate Type: Planning

Date: 2/10/2020
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 650,000	
2 - Sitework		$ 10,510,000	
	Raw Construction Subtotal	**$ 11,200,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,800,000	
		Construction Cost Subtotal	**$ 14,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 630,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,100,000	
		Total Construction Cost	**$ 16,730,000**	
	15%	Owner's Reserve for Change Orders	$ 2,510,000	
	15%	Engineering Services (Design)	$ 2,510,000	
	13%	Construction Management	$ 2,170,000	
	12%	Engineering Services During Construction	$ 2,010,000	
		Total Capital Cost	**$ 25,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 650,000	
	Traffic Control (Heavy Urban)	7%	16	28,900	LS	$ 22.40	$ 650,000	7% of Divisions 2-17
2 - Sitework							$ 10,510,000	
	16" Open cut pipeline		16	28,900	LF	$ 320	$ 9,250,000	
	16" Bore and Jack Pipeline & Casing		16	500	LF	$ 832	$ 420,000	
	Sheeting and Shoring	7%	16	28,900	LF	$ 22.40	$ 650,000	
	Potholing (Heavy Urban)	2%	16	29,400	LF	$ 6.40	$ 190,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 47,981	
Annual Inspection and Pipeline Maintenance	29,400	LF	$1.63	$ 47,981	
			TOTAL ANNUAL O&M COSTS	**$ 48,000**	

Future opportunities and alternative elements cost estimate details

Table 54. NPR+ AWPFs

Element	Unit Cost ($/AF)	Palo Alto[b] 2.25 mgd AWPF	Sunnyvale[c] 1.2 mgd AWPF	SJ/SC[d] 8 mgd AWPF
Capital Costs				
Treatment Equipment		$ 7,400,000	$ 5,200,000	
Site Improvements		$ 5,600,000	$ 5,900,000	
Electrical Improvements		$ 1,300,000	$ 900,000	
Subtotal		**$ 14,300,000**	**$ 12,000,000**	
Division 1 Costs and Mobilization (10%)		$ 1,500,000	$ 1,200,000	
Taxes on Material Costs (9%)		$ 1,000,000	$ 700,000	
Contractor Overhead and Profit (15%)		$ 2,200,000	$ 1,800,000	
Total Construction Cost		**$ 19,000,000**	**$ 15,700,000**	**$ 53,000,000**
CEQA, Permitting, Specific Studies		$ 400,000	$ 300,000	
Design, Construction Management, and Inspection		$ 2,300,000	$ 2,000,000	$ 30,000,000
Total Capital Cost		**$ 21,700,000**	**$ 18,000,000**	**$ 83,000,000**
O&M Costs				
O&M Labor		$ 500,000	$ 200,000	$ 1,700,000
Repair and Replacement	$ 40	$ 200,000	$ 100,000	$ 300,000
Chemicals	$ 100	$ 300,000	$ 200,000	$ 500,000
Electricity	$ 105	$ 300,000	$ 200,000	$ 500,000
Total O&M		**$ 1,300,000**	**$ 700,000**	**$ 3,000,000**

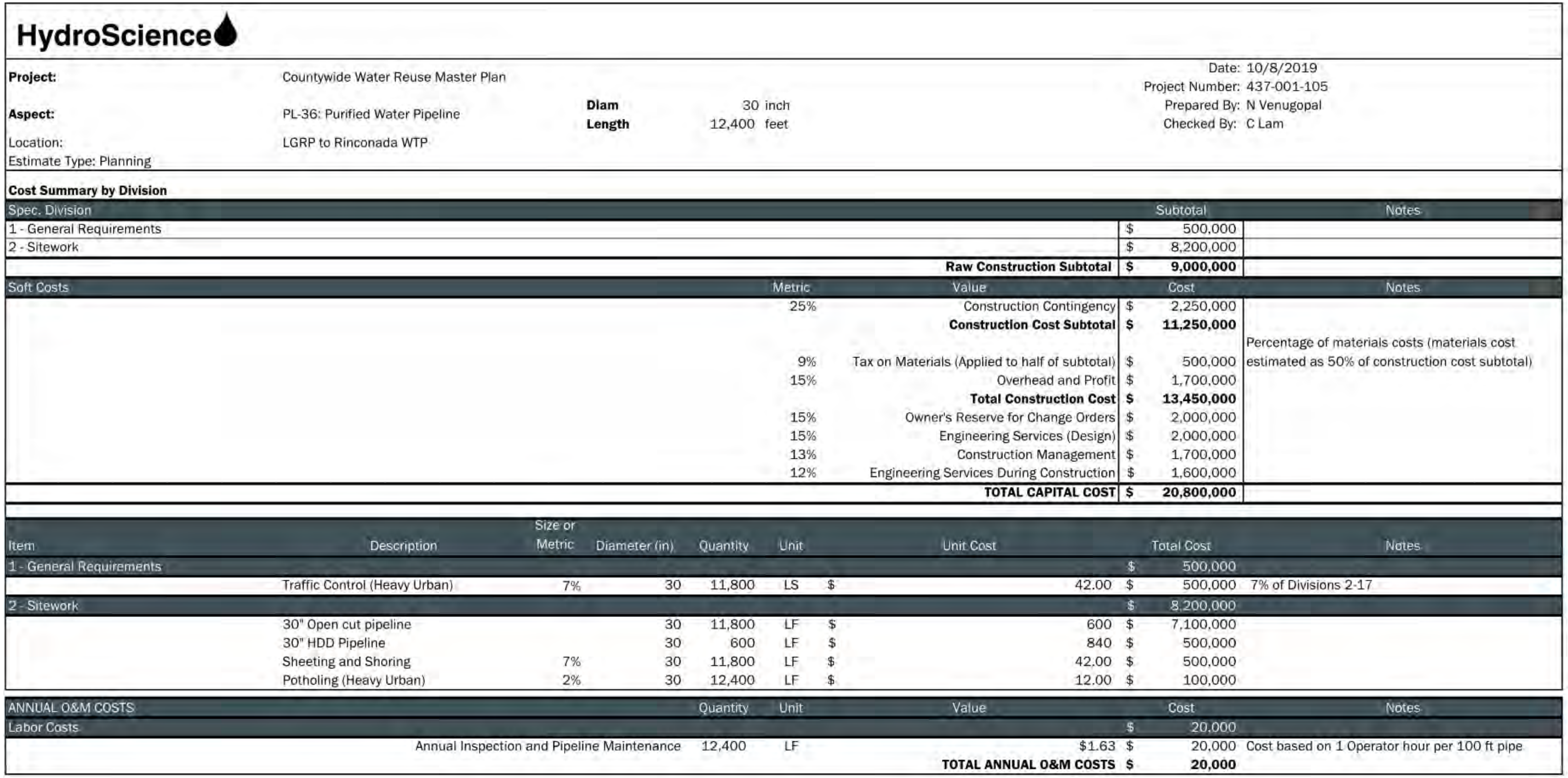
a. Costs shown in 2019 dollars and rounded up to the nearest 100,000 value.

b. Based on cost for 2.25-mgd facility in Advanced Water Purification System Preliminary/Conceptual Design Report, December 2017.

c. Cost for Sunnyvale 1.2-mgd facility estimated by scaling down the Palo Alto facility's estimated costs.

d. Cost for SJ/SC 8-mgd facility estimated based on 2011 SVAWPC construction cost from schedule of values and July 2018-June 2019 actual O&M costs.

Table 55. Purified water pipeline extension from LGRP to Rinconada WTP for RWA (PL-36; Portfolios 1a, 2a, 2b, and/or 4)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	10/8/2019
				Project Number:	437-001-105
Aspect:	PL-36: Purified Water Pipeline	**Diam**	30 inch	Prepared By:	N Venugopal
		Length	12,400 feet	Checked By:	C Lam
Location:	LGRP to Rinconada WTP				
Estimate Type: Planning					

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	500,000	
2 - Sitework	$	8,200,000	
Raw Construction Subtotal	**$**	**9,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,250,000	
		Construction Cost Subtotal	**$**	**11,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	1,700,000	
		Total Construction Cost	**$**	**13,450,000**	
	15%	Owner's Reserve for Change Orders	$	2,000,000	
	15%	Engineering Services (Design)	$	2,000,000	
	13%	Construction Management	$	1,700,000	
	12%	Engineering Services During Construction	$	1,600,000	
		TOTAL CAPITAL COST	**$**	**20,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	500,000	
	Traffic Control (Heavy Urban)	7%	30	11,800	LS	$	42.00	$	500,000	7% of Divisions 2-17
2 - Sitework								$	8,200,000	
	30" Open cut pipeline		30	11,800	LF	$	600	$	7,100,000	
	30" HDD Pipeline		30	600	LF	$	840	$	500,000	
	Sheeting and Shoring	7%	30	11,800	LF	$	42.00	$	500,000	
	Potholing (Heavy Urban)	2%	30	12,400	LF	$	12.00	$	100,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	20,000	
Annual Inspection and Pipeline Maintenance	12,400	LF	$1.63	$	20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**20,000**	

Table 56. NPR+ intertie between Mountain View and Sunnyvale

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: NPR/NPR+ Intertie
Mountain View/Sunnyvale
Estimate Type: Planning

Diam 16 inch
Length 18,560 feet

Date: 10/8/2019
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	400,000	
2 - Sitework	$	6,500,000	
Raw Construction Subtotal	**$**	**7,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,750,000	
		Construction Cost Subtotal	**$**	**8,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	1,300,000	
		Total Construction Cost	**$**	**10,450,000**	
	15%	Owner's Reserve for Change Orders	$	1,600,000	
	15%	Engineering Services (Design)	$	1,600,000	
	13%	Construction Management	$	1,400,000	
	12%	Engineering Services During Construction	$	1,300,000	
		TOTAL CAPITAL COST	**$**	**16,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	400,000	
	Traffic Control (Heavy Urban)	7%	16	18,360	LS	$	22.40	$	400,000	7% of Divisions 2-17
2 - Sitework								$	6,500,000	
	48" Open cut pipeline		16	18,360	LF	$	320	$	5,900,000	
	48" HDD Pipeline		16	200	LF	$	448	$	100,000	
	Sheeting and Shoring	7%	16	18,360	LF	$	22.40	$	400,000	
	Potholing (Heavy Urban)	2%	16	18,360	LF	$	6.40	$	100,000	

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Labor Costs					$	30,000	
	Annual Inspection and Pipeline Maintenance	18,560	LF	$1.63	$	30,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$**	**30,000**	

Table 57. NPR+ intertie between Sunnyvale and SBWR

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: NPR/NPR+ Intertie
Sunnyvale/SBWR
Estimate Type: Planning

Diam 30 inch
Length 14,970 feet

Date: 10/8/2019
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Check Date:

Cost Summary by Division

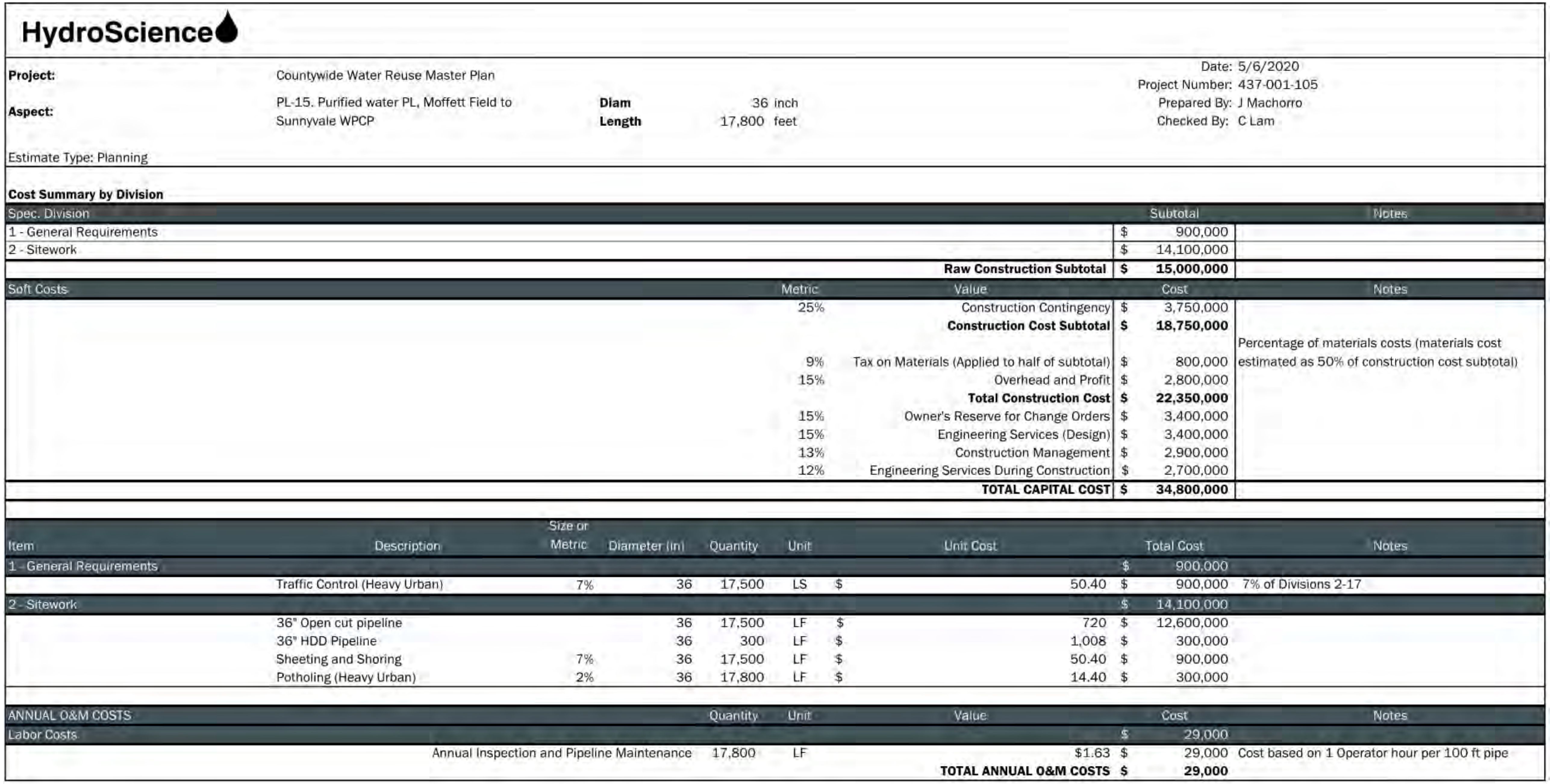
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 9,800,000	
	Raw Construction Subtotal	**$ 10,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,500,000	
		Construction Cost Subtotal	**$ 12,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,900,000	
		Total Construction Cost	**$ 15,000,000**	
	15%	Owner's Reserve for Change Orders	$ 2,300,000	
	15%	Engineering Services (Design)	$ 2,300,000	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,800,000	
		TOTAL CAPITAL COST	**$ 23,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 600,000	
	Traffic Control (Heavy Urban)	7%	30	14,720	LS	$ 42.00	$ 600,000	7% of Divisions 2-17
2 - Sitework							$ 9,800,000	
	48" Open cut pipeline		30	14,720	LF	$ 600	$ 8,800,000	
	48" HDD Pipeline		30	250	LF	$ 840	$ 200,000	
	Sheeting and Shoring	7%	30	14,720	LF	$ 42	$ 600,000	
	Potholing (Heavy Urban)	2%	30	14,720	LF	$ 12	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 24,000	
	Annual Inspection and Pipeline Maintenance	14,970	LF	$1.63	$ 24,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 24,000**	

Table 58. PL-15, 36-inch purified water pipeline from Moffett Field to Sunnyvale WPCP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-15. Purified water PL, Moffett Field to Sunnyvale WPCP

Diam 36 inch

Length 17,800 feet

Date: 5/6/2020
Project Number: 437-001-105
Prepared By: J Machorro
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

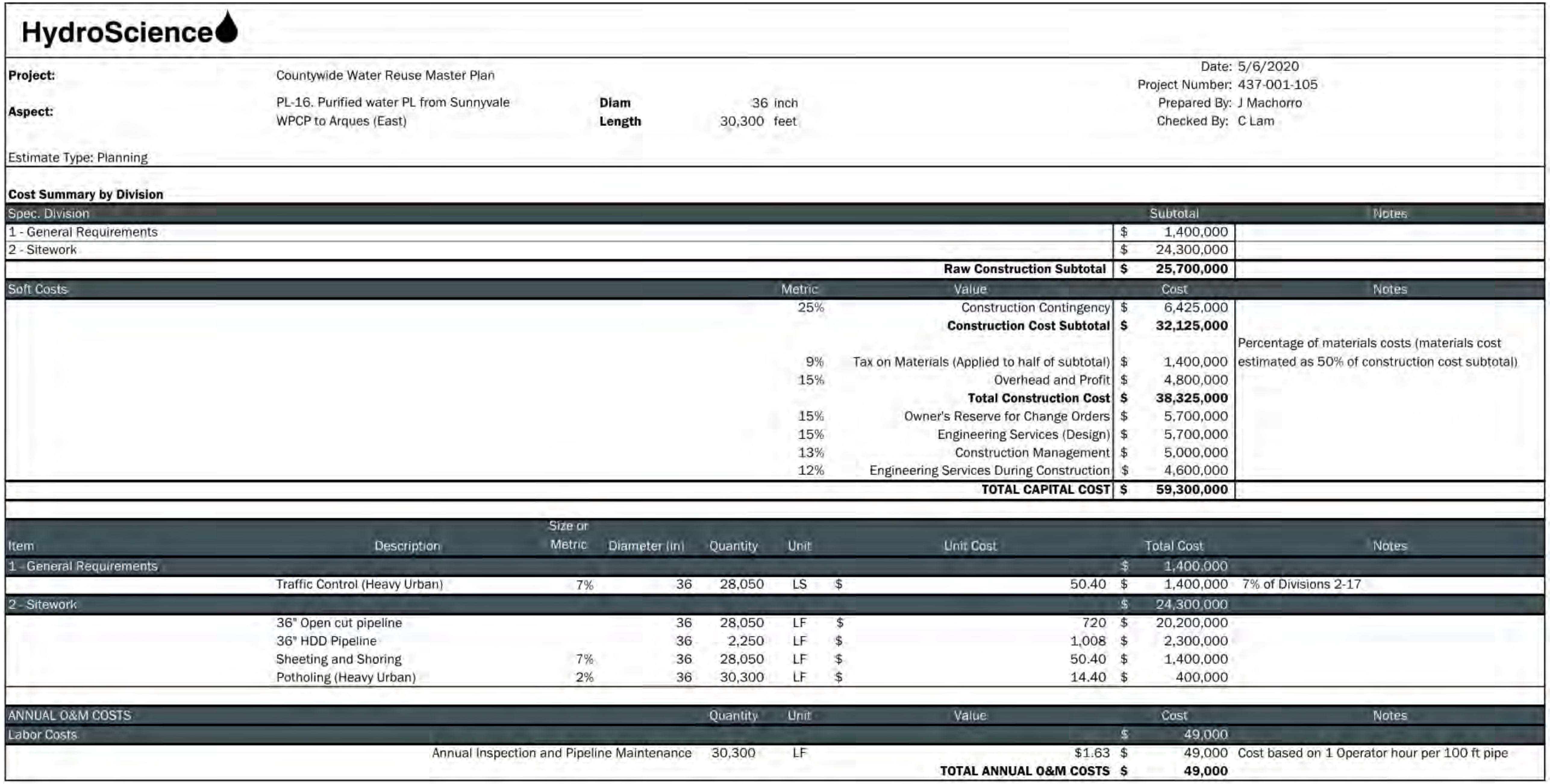
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 900,000	
2 - Sitework		$ 14,100,000	
	Raw Construction Subtotal	**$ 15,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 3,750,000	
		Construction Cost Subtotal	**$ 18,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,800,000	
		Total Construction Cost	**$ 22,350,000**	
	15%	Owner's Reserve for Change Orders	$ 3,400,000	
	15%	Engineering Services (Design)	$ 3,400,000	
	13%	Construction Management	$ 2,900,000	
	12%	Engineering Services During Construction	$ 2,700,000	
		TOTAL CAPITAL COST	**$ 34,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 900,000	
	Traffic Control (Heavy Urban)	7%	36	17,500	LS	$ 50.40	$ 900,000	7% of Divisions 2-17
2 - Sitework							$ 14,100,000	
	36" Open cut pipeline		36	17,500	LF	$ 720	$ 12,600,000	
	36" HDD Pipeline		36	300	LF	$ 1,008	$ 300,000	
	Sheeting and Shoring	7%	36	17,500	LF	$ 50.40	$ 900,000	
	Potholing (Heavy Urban)	2%	36	17,800	LF	$ 14.40	$ 300,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 29,000	
	Annual Inspection and Pipeline Maintenance	17,800	LF	$1.63	$ 29,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 29,000**	

Table 59. PL-16, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	PL-16. Purified water PL from Sunnyvale WPCP to Arques (East)	**Diam**	36 inch	Prepared By:	J Machorro
		Length	30,300 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,400,000	
2 - Sitework	$ 24,300,000	
Raw Construction Subtotal	**$ 25,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 6,425,000	
		Construction Cost Subtotal	**$ 32,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 4,800,000	
		Total Construction Cost	**$ 38,325,000**	
	15%	Owner's Reserve for Change Orders	$ 5,700,000	
	15%	Engineering Services (Design)	$ 5,700,000	
	13%	Construction Management	$ 5,000,000	
	12%	Engineering Services During Construction	$ 4,600,000	
		TOTAL CAPITAL COST	**$ 59,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 1,400,000	
	Traffic Control (Heavy Urban)	7%	36	28,050	LS	$ 50.40	$ 1,400,000	7% of Divisions 2-17
2 - Sitework							$ 24,300,000	
	36" Open cut pipeline		36	28,050	LF	$ 720	$ 20,200,000	
	36" HDD Pipeline		36	2,250	LF	$ 1,008	$ 2,300,000	
	Sheeting and Shoring	7%	36	28,050	LF	$ 50.40	$ 1,400,000	
	Potholing (Heavy Urban)	2%	36	30,300	LF	$ 14.40	$ 400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 49,000	
Annual Inspection and Pipeline Maintenance	30,300	LF	$1.63	$ 49,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 49,000**	

Table 60. PL-17, 36-inch purified water pipeline from Sunnyvale WPCP to Arques (East)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	PL-17. Purified water PL, Sunnyvale WPCP to Arques (East)	**Diam**	36 inch	Prepared By:	J Machorro
		Length	11,400 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 500,000	
2 - Sitework		$ 9,100,000	
	Raw Construction Subtotal	**$ 9,600,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,400,000	
		Construction Cost Subtotal	**$ 12,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,800,000	
		Total Construction Cost	**$ 14,300,000**	
	15%	Owner's Reserve for Change Orders	$ 2,100,000	
	15%	Engineering Services (Design)	$ 2,100,000	
	13%	Construction Management	$ 1,900,000	
	12%	Engineering Services During Construction	$ 1,700,000	
		TOTAL CAPITAL COST	**$ 22,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 500,000	
	Traffic Control (Heavy Urban)	7%	36	10,590	LS	$ 50.40	$ 500,000	7% of Divisions 2-17
2 - Sitework							$ 9,100,000	
	36" Open cut pipeline		36	10,590	LF	$ 720	$ 7,600,000	
	36" HDD Pipeline		36	810	LF	$ 1,008	$ 800,000	
	Sheeting and Shoring	7%	36	10,590	LF	$ 50.40	$ 500,000	
	Potholing (Heavy Urban)	2%	36	11,400	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 19,000	
	Annual Inspection and Pipeline Maintenance	11,400	LF	$1.63	$ 19,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 19,000**	

Table 61. PL-18, 36-inch purified water pipeline from Moffett Field to Arques (West)

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	PL-18. Purified water PL, Moffett Field to Arques (West)	**Diam**	36 inch	Prepared By:	J Machorro
		Length	12,300 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

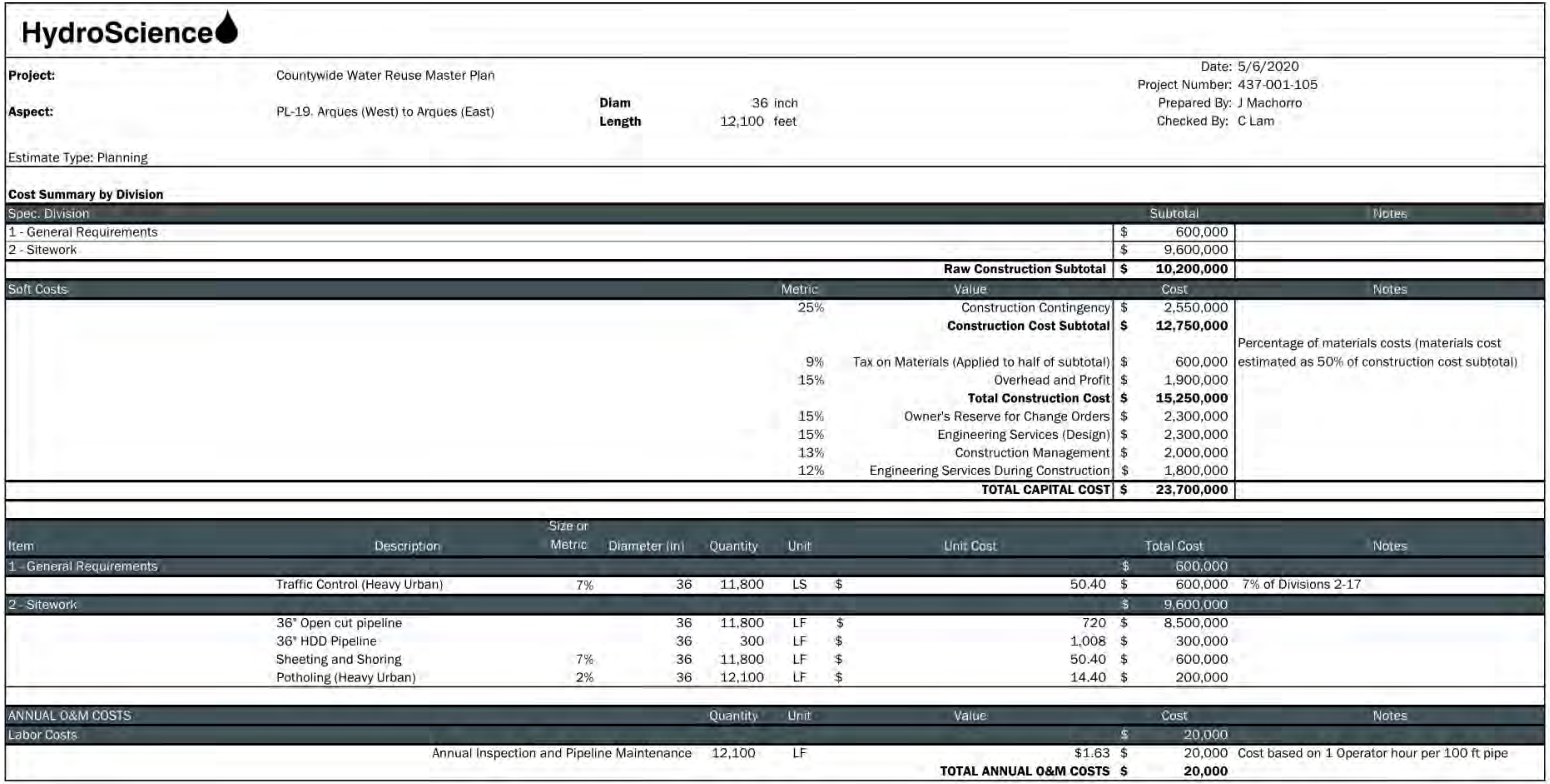
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 9,900,000	
	Raw Construction Subtotal	**$ 10,500,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,625,000	
		Construction Cost Subtotal	**$ 13,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,000,000	
		Total Construction Cost	**$ 15,725,000**	
	15%	Owner's Reserve for Change Orders	$ 2,400,000	
	15%	Engineering Services (Design)	$ 2,400,000	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,900,000	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 600,000	
	Traffic Control (Heavy Urban)	7%	36	11,400	LS	$ 50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							$ 9,900,000	
	36" Open cut pipeline		36	11,400	LF	$ 720	$ 8,200,000	
	36" HDD Pipeline		36	900	LF	$ 1,008	$ 900,000	
	Sheeting and Shoring	7%	36	11,400	LF	$ 50.40	$ 600,000	
	Potholing (Heavy Urban)	2%	36	12,300	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 20,000	
	Annual Inspection and Pipeline Maintenance	12,300	LF	$1.63	$ 20,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 20,000**	

Table 62. PL-19, 36-inch purified water pipeline from Arques (West) to Arques (East)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	PL-19. Arques (West) to Arques (East)	**Diam**	36 inch	Prepared By:	J Machorro
		Length	12,100 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

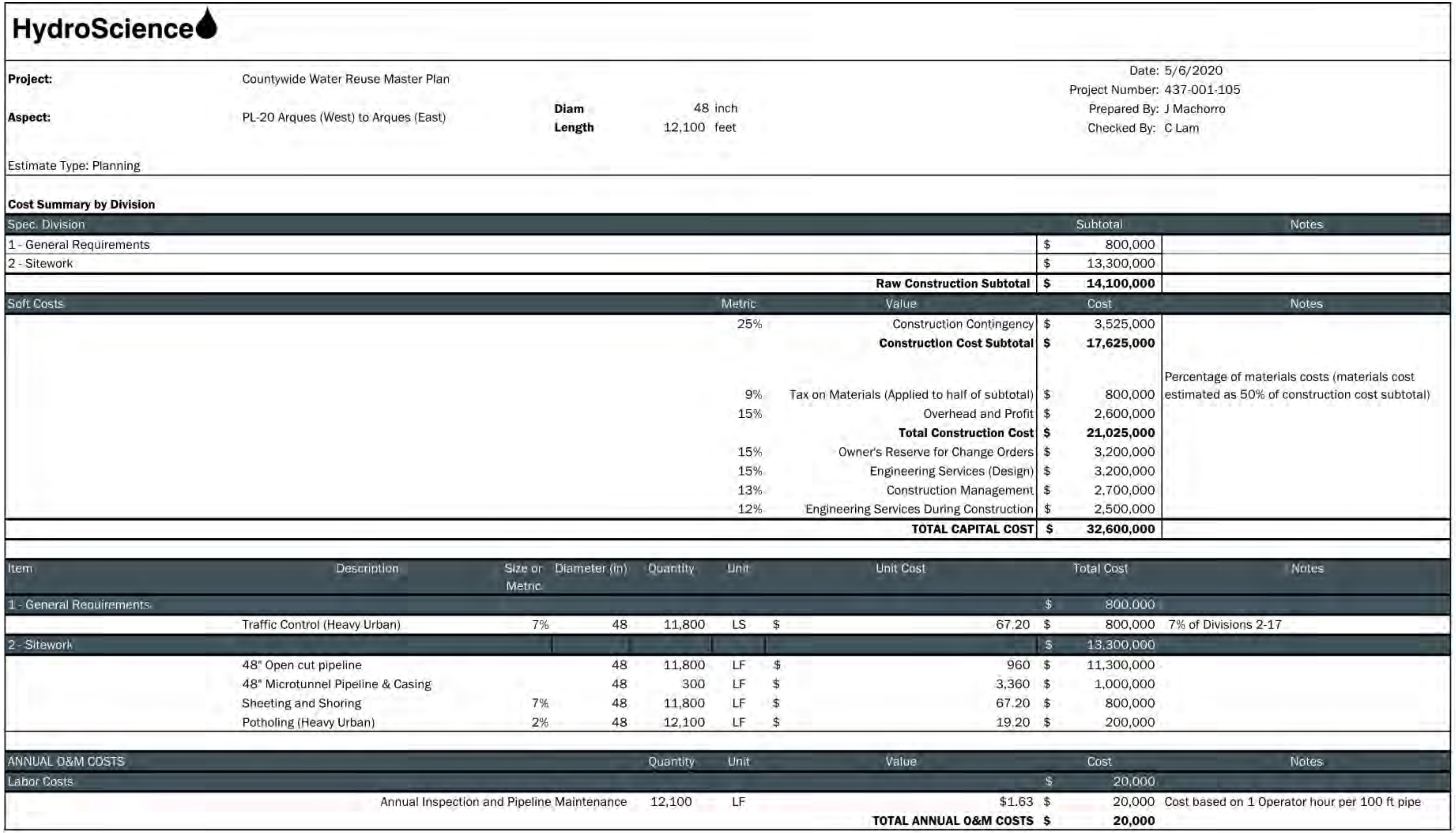
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 9,600,000	
	Raw Construction Subtotal	**$ 10,200,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,550,000	
		Construction Cost Subtotal	**$ 12,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,900,000	
		Total Construction Cost	**$ 15,250,000**	
	15%	Owner's Reserve for Change Orders	$ 2,300,000	
	15%	Engineering Services (Design)	$ 2,300,000	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,800,000	
		TOTAL CAPITAL COST	**$ 23,700,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 600,000	
	Traffic Control (Heavy Urban)	7%	36	11,800	LS	$ 50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							$ 9,600,000	
	36" Open cut pipeline		36	11,800	LF	$ 720	$ 8,500,000	
	36" HDD Pipeline		36	300	LF	$ 1,008	$ 300,000	
	Sheeting and Shoring	7%	36	11,800	LF	$ 50.40	$ 600,000	
	Potholing (Heavy Urban)	2%	36	12,100	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 20,000	
Annual Inspection and Pipeline Maintenance	12,100	LF	$1.63	$ 20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 20,000**	

Table 63. PL-20, 48-inch purified water pipeline from Arques (West) to Arques (East)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/6/2020
				Project Number:	437-001-105
Aspect:	PL-20 Arques (West) to Arques (East)	**Diam**	48 inch	Prepared By:	J Machorro
		Length	12,100 feet	Checked By:	C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	800,000	
2 - Sitework	$	13,300,000	
Raw Construction Subtotal	**$**	**14,100,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,525,000	
		Construction Cost Subtotal	**$**	**17,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,600,000	
		Total Construction Cost	**$**	**21,025,000**	
	15%	Owner's Reserve for Change Orders	$	3,200,000	
	15%	Engineering Services (Design)	$	3,200,000	
	13%	Construction Management	$	2,700,000	
	12%	Engineering Services During Construction	$	2,500,000	
		TOTAL CAPITAL COST	**$**	**32,600,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								$	800,000	
	Traffic Control (Heavy Urban)	7%	48	11,800	LS	$	67.20	$	800,000	7% of Divisions 2-17
2 - Sitework								$	13,300,000	
	48" Open cut pipeline		48	11,800	LF	$	960	$	11,300,000	
	48" Microtunnel Pipeline & Casing		48	300	LF	$	3,360	$	1,000,000	
	Sheeting and Shoring	7%	48	11,800	LF	$	67.20	$	800,000	
	Potholing (Heavy Urban)	2%	48	12,100	LF	$	19.20	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	20,000	
Annual Inspection and Pipeline Maintenance	12,100	LF	$1.63	$	20,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**20,000**	

Table 64. PL-31, 48-inch purified water pipeline from Sunnyvale WPCP to LGRP

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-31. Purified water PL from connection near Sunnyvale WPCP to LGRP (alternate alignment for Portfolio 2a, w/ PL-33, and Portfolio 2b)

Diam 48 inch
Length 89,600 feet

Date: 5/6/2020
Project Number: 437-001-105
Prepared By: J Machorro
Checked By: C Lam

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 5,800,000	
2 - Sitework		$ 100,600,000	
	Raw Construction Subtotal	**$ 106,400,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 26,600,000	
		Construction Cost Subtotal	**$ 133,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,000,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 20,000,000	
		Total Construction Cost	**$ 159,000,000**	
	15%	Owner's Reserve for Change Orders	$ 23,900,000	
	15%	Engineering Services (Design)	$ 23,900,000	
	13%	Construction Management	$ 20,700,000	
	12%	Engineering Services During Construction	$ 19,100,000	
		TOTAL CAPITAL COST	**$ 246,600,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 5,800,000	
	Traffic Control (Heavy Urban)	7%	48	85,770	LS	$ 67.20	$ 5,800,000	7% of Divisions 2-17
2 - Sitework							$ 100,600,000	
	48" Open cut pipeline		48	85,770	LF	$ 960	$ 82,300,000	
	48" Bore and Jack Pipeline & Casing		48	2,410	LF	$ 2,496	$ 6,000,000	
	48" Microtunnel Pipeline & Casing		48	1,420	LF	$ 3,360	$ 4,800,000	
	Sheeting and Shoring	7%	48	85,770	LF	$ 67.20	$ 5,800,000	
	Potholing (Heavy Urban)	2%	48	89,600	LF	$ 19.20	$ 1,700,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 175,000	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table 65. PL-32, 48-inch purified water pipeline from Arques (West) to LGRP

HydroScience

Project:	Countywide Water Reuse Master Plan			Date: 5/7/2020 Project Number: 437-001-105
Aspect:	PL-32. Purified water PL, from Arques (West) to LGRP (alternate alignment for Portfolio 2a, second part of PL-7, and Portfolio 4)	**Diam**	48 inch	Prepared By: J Machorro
		Length	72,500 feet	Checked By: C Lam
Estimate Type: Planning				

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 4,700,000	
2 - Sitework		$ 81,600,000	
	Raw Construction Subtotal	**$ 86,300,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 21,575,000	
		Construction Cost Subtotal	**$ 107,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 4,900,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 16,200,000	
		Total Construction Cost	**$ 128,975,000**	
	15%	Owner's Reserve for Change Orders	$ 19,300,000	
	15%	Engineering Services (Design)	$ 19,300,000	
	13%	Construction Management	$ 16,800,000	
	12%	Engineering Services During Construction	$ 15,500,000	
		TOTAL CAPITAL COST	**$ 199,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 4,700,000	
	Traffic Control (Heavy Urban)	7%	48	69,480	LS	$ 67.20	$ 4,700,000	7% of Divisions 2-17
2 - Sitework							$ 81,600,000	
	48" Open cut pipeline		48	69,480	LF	$ 960	$ 66,700,000	
	48" Bore and Jack Pipeline & Casing		48	1,600	LF	$ 2,496	$ 4,000,000	
	48" Microtunnel Pipeline & Casing		48	1,420	LF	$ 3,360	$ 4,800,000	
	Sheeting and Shoring	7%	48	69,480	LF	$ 67.20	$ 4,700,000	
	Potholing (Heavy Urban)	2%	48	72,500	LF	$ 19.20	$ 1,400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 118,000	
Annual Inspection and Pipeline Maintenance	72,500	LF	$1.63	$ 118,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 118,000**	

Table 66. PL-33, 36-inch purified water pipeline from Palo Alto AWPF to Sunnyvale WPCP

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/7/2020
				Project Number:	437-001-105
Aspect:	PL-33. Purified water PL from Palo Alto AWPF to connection near Sunnyvale WPCP (Portfolio 2a alternate alignment, w/ either PL-9 or PL-31)	**Diam**	36 inch	Prepared By:	J Machorro
		Length	38,820 feet	Checked By:	C Lam
Estimate Type: Planning					

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 1,900,000	
2 - Sitework	$ 30,700,000	
Raw Construction Subtotal	**$ 32,600,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 8,200,000	
		Construction Cost Subtotal	**$ 40,800,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 6,100,000	
		Total Construction Cost	**$ 48,700,000**	
	15%	Owner's Reserve for Change Orders	$ 7,300,000	
	15%	Engineering Services (Design)	$ 7,300,000	
	13%	Construction Management	$ 6,300,000	
	12%	Engineering Services During Construction	$ 5,800,000	
		TOTAL CAPITAL COST	**$ 75,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 1,900,000	
	Traffic Control (Heavy Urban)	7%	36	38,170	LS	$ 50.40	$ 1,900,000	7% of Divisions 2-17
2 - Sitework							$ 30,700,000	
	36" Open cut pipeline		36	38,170	LF	$ 720	$ 27,500,000	
	36" HDD Pipeline		36	650	LF	$ 1,008	$ 700,000	
	Sheeting and Shoring	7%	36	38,170	LF	$ 50.40	$ 1,900,000	
	Potholing (Heavy Urban)	2%	36	38,820	LF	$ 14.40	$ 600,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					$ 63,000	
	Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$ 63,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 63,000**	

Table 67. PL-44, 36-inch pipeline from PA AWPF to West Pipeline at Stevens Creek Blvd (West County TWA)

HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PL-44 - PA AWPF to West Pipeline at Stevens Creek Blvd (West County TWA)
Diam 36 inch
Length 56,600 feet
Estimate Type: Planning

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 2,700,000	
2 - Sitework		$ 45,300,000	
	Raw Construction Subtotal	**$ 48,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 12,000,000	
		Construction Cost Subtotal	**$ 60,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 2,700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 9,000,000	
		Total Construction Cost	**$ 71,700,000**	
	15%	Owner's Reserve for Change Orders	$ 10,800,000	
	15%	Engineering Services (Design)	$ 10,800,000	
	13%	Construction Management	$ 9,320,000	
	12%	Engineering Services During Construction	$ 8,600,000	
		Total Capital Cost	**$ 111,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ 2,700,000	
	Traffic Control (Heavy Urban)	7%	36	54,350	LS	$ 50.40	$ 2,700,000	7% of Divisions 2-17
2 - Sitework							$ 45,300,000	
	36" Open cut pipeline		36	54,350	LF	$ 720	$ 39,100,000	
	36" HDD Pipeline		36	1,700	LF	$ 1,008	$ 1,700,000	
	Sheeting and Shoring	7%	36	54,350	LF	$ 50.40	$ 2,700,000	
	Potholing (Heavy Urban)	2%	36	56,600	LF	$ 14.40	$ 800,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				$ 92,000	
Annual Inspection and Pipeline Maintenance	56,600	LF	$1.63	$ 92,000	
			TOTAL ANNUAL O&M COSTS	**$ 92,000**	

Table 68. Westside AWPF (West County Treated Water Augmentation)

Brown AND Caldwell

Focus: Cost Summary
Element: AWPF (Westside TWA)
Capacity / Treatment: 24 mgd
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

Capital Costs			
Raw / Construction Costs		**$**	**162,000,000**
Contingency - Treatment Facility	25%	$	41,000,000
Construction Cost Subtotal		**$**	**203,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	10,000,000
General Contractor Overhead and Profit	15%	$	31,000,000
Estimated Total Construction Cost		**$**	**244,000,000**
Owner's Reserve for Change Orders	15%	$	37,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	37,000,000
Construction Management	13%	$	32,000,000
Engineering Services During Construction	12%	$	30,000,000
Total Capital Cost		**$**	**380,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	3,640,000
Energy/Power	$	5,760,000
Chemicals	$	2,910,000
Labor	$	3,850,000
Total Annual O&M Cost	**$**	**16,160,000**

Replacement and Renewal Costs*		
100-yr Lifecycle (present value, $2019)	$	174,000,000
30-yr Lifecycle (present value, $2019)	$	75,000,000

*See Appendix A-5 (Basis of Cost) for explanation of methodology

AWPF Unit Cost ($/AF)			
Annualized Capital Cost	3%, 30 yrs	$	19,390,000
Annual O&M Cost		$	16,160,000
Annual R&R Cost	annual average of 30-yr lifecycle	$	2,500,000
Total Annual Cost		**$**	**38,050,000**
Annual Yield	**AF**		**18,500**
AWPF Unit Cost, 30-yr Lifecycle ($/AF)		**$**	**2,060**

Construction Costs by Division	**Cost Summary**		**% of Total Cost**
Division 01 - General Requirements	$	14,700,500	9%
Division 02 - Site Construction	$	-	0%
Division 03 - Concrete	$	9,474,800	6%
Division 04 - Masonry	$	-	0%
Division 05 - Metals	$	750,000	0%
Division 06 - Woods, Plastics, and Composites	$	-	0%
Division 07 - Thermal and Moisture Protection	$	-	0%
Division 08 - Doors and Windows	$	-	0%
Division 09 - Finishes	$	1,000,000	1%
Division 10 - Specialties	$	-	0%
Division 11 - Equipment	$	-	0%
Division 12 - Furnishings	$	-	0%
Division 13 - Special Construction	$	-	0%
Division 14 - Conveying Systems	$	-	0%
Division 15 - Mechanical	$	-	0%
Division 17 - Instrumentation	$	5,173,300	3%
Division 21 - Fire Suppression	$	-	0%
Division 22 - Plumbing	$	-	0%
Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)	$	-	0%
Division 26 - Electrical	$	20,692,900	13%
Division 27 - Communications	$	-	0%
Division 28 - Electronic Safety and Security	$	-	0%
Division 31 - Earthwork	$	4,054,200	3%
Division 32 - Exterior Improvements	$	111,200	0%
Division 33 - Utilities	$	-	0%
Division 40 - Process Integration	$	21,497,000	13%
Division 41 - Material Processing and Handling Equipment	$	-	0%
Division 42 - Process Heating, Cooling, and Drying Equipment	$	-	0%
Division 43 - Process Gas and Liquid Handling, Purification, and Storage	$	21,941,800	14%
Division 44 - Pollution and Waste Control Equipment	$	-	0%
Division 46 - Water and Wastewater Equipment	$	62,309,600	38%
TOTAL	**$**	**162,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF (Westside TWA)
Capacity: 24 mgd
Location: Palo Alto

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 147,004,800	10% of Divisions 2-47	$ 14,700,500	
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here
Division 31 – Earthwork	Sitework	Excavation		39,685	CY		$ 11.78			$ 467,500	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500	
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500	
Division 31 – Earthwork	Sitework	Gravel		10,294	SY		$ 4.63			$ 47,700	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ 119,500	Ozone and LOX Area
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ 56,800	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ 206,400	Ozone and LOX Area
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ 627,900	Ozone and LOX Area
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ 275,200	BAC
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ 327,000	BAC
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ 346,900	Treatment Equipment

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Aspect: AWPF (Westside TWA)
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ 253,600	Treatment Equipment
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ 130,100	Treatment Equipment
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 750,000	Engineer's Estimate	$ 750,000	for 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 1,000,000	Engineer's Estimate	$ 1,000,000	for 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ 7,455,900	
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ 5,741,700	
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	100	10	ea	$ 47,545			Interpolate from feed pumps on equip page	$ 475,500	
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 10,341,971			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 10,342,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	5	EA	$ 71,786				$ 359,000	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 27,390,000			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 27,390,000	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	4	EA	$ 29,364				$ 117,500	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 1,513,749			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 1,513,800	Filtration Treatment
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	4	EA	$ 35,424				$ 141,700	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	3	EA	$ 9,315			Assumed 18" flowmeter	$ 28,000	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		3	EA		$ 12,132			$ 36,400	UV/AOP

Brown AND Caldwell

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C Assumptions	Cost - Total	Notes
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 6,799,239			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 6,799,300	UV/AOP
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		1	EA		$ 534,375		Need two tanks (approx 170,000 gallons each) assume 1 of 376,000 steel tank for costs, assumes 15 minutes of feed to the RO system at ultimate flows	$ 534,400	Storage Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	2	EA	$ 3,650,000			From DN Tanks cost proposal, need two 4 MG tanks	$ 7,300,000	Prestressed Concrete Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	2	EA	$ 4,310			Assumes 30 day storage	$ 8,700	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	2	EA	$ 12,275			Assumes 30 day storage	$ 24,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	2	EA	$ 5,793			Assumes 30 day storage	$ 11,600	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	2	EA	$ 48,000			Assumes 30 day storage	$ 96,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	2	EA	$ 220,500			Assumes 7 day storage	$ 441,000	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	2	EA	$ 13,440			Assumes 30 day storage	$ 26,900	Chemical Tanks
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz. Carbon Steel)	1,000	2	EA	$ 12,000			Assumes 30 day storage	$ 24,000	Chemical Tanks

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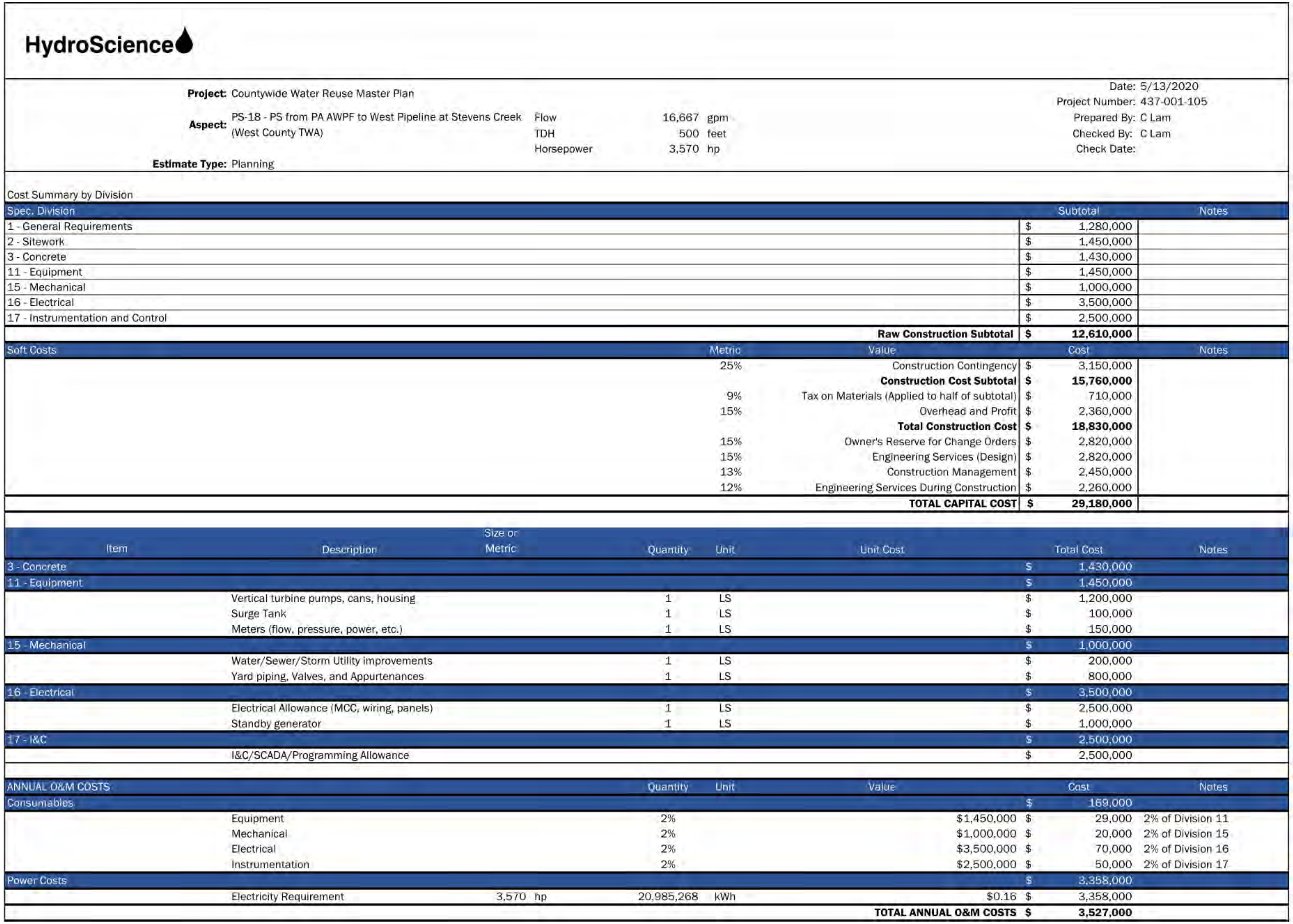
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 62,309,600	30% of Equipment Costs	$ 18,692,900	
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 18,692,900	5% of Piping Allowance	$ 934,700	
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 18,692,900	5% of Piping Allowance	$ 934,700	
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 18,692,900	5% of Piping Allowance	$ 934,700	
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 62,309,600	30% of Equipment Costs	$ 18,692,900	
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 20,692,900	25% of Electrical Costs	$ 5,173,300	
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ 1,046,200	
O&M	Consumables	UF Membranes Replacement		810	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 1,604,100	
O&M	Consumables	RO Membranes Replacement		924	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 320,800	installation costs must be covered by O&M labor
O&M	Consumables	UV Lamp Replacement		420	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 82,500	installation costs must be covered by O&M labor
O&M	Consumables	UV Ballast Replacement		58	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 45,800	installation costs must be covered by O&M labor
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,220,000	2% of Pumping Equipment Cost	$ 24,400	
O&M	Consumables	Electrical Consumables		2%	% of			$ 20,692,900	2% of Electrical Cost	$ 413,900	
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 5,173,300	2% of Instrumentation & Controls Cost	$ 103,500	
O&M	Power	Influent Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ 290,800	
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ 14,900	
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ 21,800	
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ 30,500	
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ 11,900	
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ 4,000	
O&M	Power	UF Air Scour		10,249	kWh		$ 0.10			$ 1,100	
O&M	Power	UF CIP		13,403	kWh		$ 0.10			$ 1,400	
O&M	Power	RO Transfer Pumps		5,227,968	kWh		$ 0.10			$ 540,900	
O&M	Power	RO Feed Pumps		32,674,800	kWh		$ 0.10			$ 3,380,400	
O&M	Power	RO Inter-Stage Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	RO CIP		2,362	kWh		$ 0.10			$ 300	
O&M	Power	Decarbonator Feed Pumps		653,496	kWh		$ 0.10			$ 67,700	
O&M	Power	Decarbonator Blowers		522,797	kWh		$ 0.10			$ 54,100	
O&M	Power	UV/AOP Transfer Pumps		1,306,992	kWh		$ 0.10			$ 135,300	
O&M	Power	UV System		4,380,000	kWh		$ 0.10			$ 453,200	
O&M	Power	RO Concentrate Waste Pumps		1,176,293	kWh		$ 0.10			$ 121,700	
O&M	Power	Waste Equalization Pumps		196,049	kWh		$ 0.10			$ 20,300	
O&M	Power	Chemical Metering Pumps		45,745	kWh		$ 0.10		Assumed 7 duty chemical metering pumps	$ 4,800	
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ 21,100	
O&M	Chemicals	Sodium Bisulfite		51,600	gal		$ 2.25		Costs based on Expedited Purified Water Program Estimates	$ 116,100	
O&M	Chemicals	Aq. Ammonia		31,000	gal		$ 0.10		Costs based on Expedited Purified Water Program Estimates	$ 3,100	
O&M	Chemicals	Citric Acid		3,600	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 20,100	
O&M	Chemicals	Hydrogen Peroxide		60,000	gal		$ 5.14		Costs based on Expedited Purified Water Program Estimates	$ 308,300	

Focus: Cost Inputs and R&R
Aspect: AWPF (Westside TWA)
Capacity: 24 mgd
Location: Palo Alto

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	Cost - Total	Notes
O&M	Chemicals	Sodium Hydroxide		96,000	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 276,800	
O&M	Chemicals	Sodium Hypochlorite		2,114,000	gal		$ 0.61		Costs based on Expedited Purified Water Program Estimates	$ 1,289,600	
O&M	Chemicals	Lime		877,226	lb		$ 0.15		based on 12 mg/L dose	$ 131,500	
O&M	Chemicals	Sulfuric Acid		26,880	gal		$ 1.00		Costs based on Expedited Purified Water Program Estimates	$ 26,900	
O&M	Chemicals	RO Antiscalant		26,400	gal		$ 20.56		Costs based on Expedited Purified Water Program Estimates	$ 542,900	
O&M	Chemicals	RO Low pH Cleaner		20,400	gal		$ 5.57		Costs based on Expedited Purified Water Program Estimates	$ 113,700	
O&M	Chemicals	RO High pH Cleaner		20,400	gal		$ 2.88		Costs based on Expedited Purified Water Program Estimates	$ 58,900	
O&M	Labor	Water Plant Operator		8,320	hours/yr		$ 163.20			$ 1,357,900	Assumes three plant operators 40 hours per week for 52 weeks in a year (4 FTE)
O&M	Labor	Sr Mechanics		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two senior mechanics 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Control Tech II		6,240	hours/yr		$ 172.27			$ 1,075,000	Assumes two control tech 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)

Table 69. PS-18, pump station to convey Palo Alto AWPF purified water to West Pipeline at Stevens Creek (West County TWA)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-18 - PS from PA AWPF to West Pipeline at Stevens Creek (West County TWA)

Estimate Type: Planning

Flow	16,667	gpm
TDH	500	feet
Horsepower	3,570	hp

Date: 5/13/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,280,000	
2 - Sitework	$	1,450,000	
3 - Concrete	$	1,430,000	
11 - Equipment	$	1,450,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,500,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,610,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,150,000	
		Construction Cost Subtotal	**$**	**15,760,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	710,000	
	15%	Overhead and Profit	$	2,360,000	
		Total Construction Cost	**$**	**18,830,000**	
	15%	Owner's Reserve for Change Orders	$	2,820,000	
	15%	Engineering Services (Design)	$	2,820,000	
	13%	Construction Management	$	2,450,000	
	12%	Engineering Services During Construction	$	2,260,000	
		TOTAL CAPITAL COST	**$**	**29,180,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
3 - Concrete						$	1,430,000	
11 - Equipment						$	1,450,000	
	Vertical turbine pumps, cans, housing		1	LS		$	1,200,000	
	Surge Tank		1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$	150,000	
15 - Mechanical						$	1,000,000	
	Water/Sewer/Storm Utility improvements		1	LS		$	200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$	800,000	
16 - Electrical						$	3,500,000	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$	2,500,000	
	Standby generator		1	LS		$	1,000,000	
17 - I&C						$	2,500,000	
	I&C/SCADA/Programming Allowance					$	2,500,000	

ANNUAL O&M COSTS			Quantity	Unit	Value		Cost	Notes
Consumables						$	169,000	
	Equipment		2%		$1,450,000	$	29,000	2% of Division 11
	Mechanical		2%		$1,000,000	$	20,000	2% of Division 15
	Electrical		2%		$3,500,000	$	70,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$	50,000	2% of Division 17
Power Costs						$	3,358,000	
	Electricity Requirement	3,570 hp	20,985,268	kWh	$0.16	$	3,358,000	
					TOTAL ANNUAL O&M COSTS	**$**	**3,527,000**	

Lifecycle Costs

Table 70. Life-cycle cost for Portfolio 1a

Portfolio 1a

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 1,900	$ 2,400	$ 1,600	$ 2,000	$ 200	200	$ 2,100	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,400	$ 3,000	$ 2,200	$ 2,700	$ 200	200	$ 2,600	$ 3,200

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	$635,000,000	$1,960,000,000	$1,065,000,000	$3,660,000,000	$1,365,000,000	2,400,000	742,000	1,900,000	587,000
	30-Yr Lifecycle:	$635,000,000	$590,000,000	$190,000,000	$1,415,000,000	$975,000,000	720,000	419,000	570,000	331,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$158,750,000		$0	$158,750,000	$140,811,317				
2025		$158,750,000		$0	$158,750,000	$137,474,556				
2026		$158,750,000		$0	$158,750,000	$134,216,865				
2027		$158,750,000		$0	$158,750,000	$131,036,370				
2028	Year 1		$19,600,000	$0	$19,600,000	$15,794,976	24,000	19,341	19,000	15,311
2029	Year 2		$19,600,000	$0	$19,600,000	$15,420,687	24,000	18,882	19,000	14,949
2030	Year 3		$19,600,000	$0	$19,600,000	$15,055,268	24,000	18,435	19,000	14,594
2031	Year 4		$19,600,000	$0	$19,600,000	$14,698,508	24,000	17,998	19,000	14,249
2032	Year 5		$19,600,000	$0	$19,600,000	$14,350,202	24,000	17,572	19,000	13,911
2033	Year 6		$19,600,000	$0	$19,600,000	$14,010,150	24,000	17,155	19,000	13,581
2034	Year 7		$19,600,000	$0	$19,600,000	$13,678,156	24,000	16,749	19,000	13,259
2035	Year 8		$19,600,000	$365,116	$19,965,116	$13,602,793	24,000	16,352	19,000	12,945
2036	Year 9		$19,600,000	$0	$19,600,000	$13,037,583	24,000	15,964	19,000	12,638
2037	Year 10		$19,600,000	$2,203,078	$21,803,078	$14,159,359	24,000	15,586	19,000	12,339
2038	Year 11		$19,600,000	$0	$19,600,000	$12,427,009	24,000	15,217	19,000	12,047
2039	Year 12		$19,600,000	$0	$19,600,000	$12,132,530	24,000	14,856	19,000	11,761
2040	Year 13		$19,600,000	$0	$19,600,000	$11,845,029	24,000	14,504	19,000	11,482
2041	Year 14		$19,600,000	$0	$19,600,000	$11,564,341	24,000	14,160	19,000	11,210
2042	Year 15		$19,600,000	$2,184,046	$21,784,046	$12,548,394	24,000	13,825	19,000	10,945
2043	Year 16		$19,600,000	$365,116	$19,965,116	$11,228,098	24,000	13,497	19,000	10,685
2044	Year 17		$19,600,000	$0	$19,600,000	$10,761,559	24,000	13,177	19,000	10,432
2045	Year 18		$19,600,000	$0	$19,600,000	$10,506,546	24,000	12,865	19,000	10,185

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2046	Year 19		$19,600,000	$0	$19,600,000	$10,257,576	24,000	12,560	19,000	9,944
2047	Year 20		$19,600,000	$25,597,927	$45,197,927	$23,093,616	24,000	12,263	19,000	9,708
2048	Year 21		$19,600,000	$0	$19,600,000	$9,777,195	24,000	11,972	19,000	9,478
2049	Year 22		$19,600,000	$0	$19,600,000	$9,545,508	24,000	11,688	19,000	9,253
2050	Year 23		$19,600,000	$0	$19,600,000	$9,319,311	24,000	11,411	19,000	9,034
2051	Year 24		$19,600,000	$365,116	$19,965,116	$9,267,964	24,000	11,141	19,000	8,820
2052	Year 25		$19,600,000	$148,216,597	$167,816,597	$76,055,768	24,000	10,877	19,000	8,611
2053	Year 26		$19,600,000	$0	$19,600,000	$8,672,376	24,000	10,619	19,000	8,407
2054	Year 27		$19,600,000	$0	$19,600,000	$8,466,869	24,000	10,368	19,000	8,208
2055	Year 28		$19,600,000	$0	$19,600,000	$8,266,232	24,000	10,122	19,000	8,013
2056	Year 29		$19,600,000	$0	$19,600,000	$8,070,350	24,000	9,882	19,000	7,823
2057	Year 30		$19,600,000	$9,467,324	$29,067,324	$11,684,930	24,000	9,648	19,000	7,638
2058	Year 31		$19,600,000	$0	$19,600,000	$7,692,401	24,000	9,419	19,000	7,457
2059	Year 32		$19,600,000	$25,927	$19,625,927	$7,520,051	24,000	9,196	19,000	7,280
2060	Year 33		$19,600,000	$339,189	$19,939,189	$7,459,039	24,000	8,978	19,000	7,108
2061	Year 34		$19,600,000	$0	$19,600,000	$7,158,404	24,000	8,765	19,000	6,939
2062	Year 35		$19,600,000	$0	$19,600,000	$6,988,774	24,000	8,558	19,000	6,775
2063	Year 36		$19,600,000	$0	$19,600,000	$6,823,163	24,000	8,355	19,000	6,614
2064	Year 37		$19,600,000	$0	$19,600,000	$6,661,476	24,000	8,157	19,000	6,458
2065	Year 38		$19,600,000	$0	$19,600,000	$6,503,622	24,000	7,964	19,000	6,305
2066	Year 39		$19,600,000	$0	$19,600,000	$6,349,507	24,000	7,775	19,000	6,155
2067	Year 40		$19,600,000	$28,904,596	$48,504,596	$15,340,927	24,000	7,591	19,000	6,009
2068	Year 41		$19,600,000	$339,189	$19,939,189	$6,156,884	24,000	7,411	19,000	5,867
2069	Year 42		$19,600,000	$0	$19,600,000	$5,908,732	24,000	7,235	19,000	5,728
2070	Year 43		$19,600,000	$0	$19,600,000	$5,768,715	24,000	7,064	19,000	5,592
2071	Year 44		$19,600,000	$0	$19,600,000	$5,632,016	24,000	6,896	19,000	5,460
2072	Year 45		$19,600,000	$2,184,046	$21,784,046	$6,111,265	24,000	6,733	19,000	5,330
2073	Year 46		$19,600,000	$0	$19,600,000	$5,368,258	24,000	6,573	19,000	5,204
2074	Year 47		$19,600,000	$0	$19,600,000	$5,241,048	24,000	6,418	19,000	5,081
2075	Year 48		$19,600,000	$25,927	$19,625,927	$5,123,621	24,000	6,266	19,000	4,960
2076	Year 49		$19,600,000	$339,189	$19,939,189	$5,082,052	24,000	6,117	19,000	4,843
2077	Year 50		$19,600,000	$182,593,887	$202,193,887	$50,313,484	24,000	5,972	19,000	4,728
2078	Year 51		$19,600,000	$0	$19,600,000	$4,761,647	24,000	5,831	19,000	4,616
2079	Year 52		$19,600,000	$0	$19,600,000	$4,648,812	24,000	5,692	19,000	4,507
2080	Year 53		$19,600,000	$0	$19,600,000	$4,538,650	24,000	5,558	19,000	4,400
2081	Year 54		$19,600,000	$0	$19,600,000	$4,431,100	24,000	5,426	19,000	4,295
2082	Year 55		$19,600,000	$0	$19,600,000	$4,326,097	24,000	5,297	19,000	4,194
2083	Year 56		$19,600,000	$25,927	$19,625,927	$4,229,170	24,000	5,172	19,000	4,094
2084	Year 57		$19,600,000	$0	$19,600,000	$4,123,498	24,000	5,049	19,000	3,997
2085	Year 58		$19,600,000	$339,189	$19,939,189	$4,095,453	24,000	4,930	19,000	3,903
2086	Year 59		$19,600,000	$0	$19,600,000	$3,930,387	24,000	4,813	19,000	3,810
2087	Year 60		$19,600,000	$32,381,645	$51,981,645	$10,176,866	24,000	4,699	19,000	3,720
2088	Year 61		$19,600,000	$6,215	$19,606,215	$3,747,508	24,000	4,587	19,000	3,632
2089	Year 62		$19,600,000	$9,133	$19,609,133	$3,659,249	24,000	4,479	19,000	3,546
2090	Year 63		$19,600,000	$13,290	$19,613,290	$3,573,294	24,000	4,372	19,000	3,462
2091	Year 64		$19,600,000	$45,070	$19,645,070	$3,494,272	24,000	4,269	19,000	3,380
2092	Year 65		$19,600,000	$27,302	$19,627,302	$3,408,384	24,000	4,168	19,000	3,299

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2093	Year 66		$19,600,000	$377,740	$19,977,740	$3,387,029	24,000	4,069	19,000	3,221
2094	Year 67		$19,600,000	$53,893	$19,653,893	$3,253,164	24,000	3,973	19,000	3,145
2095	Year 68		$19,600,000	$74,590	$19,674,590	$3,179,420	24,000	3,878	19,000	3,070
2096	Year 69		$19,600,000	$102,208	$19,702,208	$3,108,435	24,000	3,787	19,000	2,998
2097	Year 70		$19,600,000	$3,730,325	$23,330,325	$3,593,623	24,000	3,697	19,000	2,927
2098	Year 71		$19,600,000	$186,233	$19,786,233	$2,975,497	24,000	3,609	19,000	2,857
2099	Year 72		$19,600,000	$273,573	$19,873,573	$2,917,811	24,000	3,524	19,000	2,790
2100	Year 73		$19,600,000	$326,034	$19,926,034	$2,856,188	24,000	3,440	19,000	2,723
2101	Year 74		$19,600,000	$764,150	$20,364,150	$2,849,817	24,000	3,359	19,000	2,659
2102	Year 75		$19,600,000	$204,377,875	$223,977,875	$30,601,352	24,000	3,279	19,000	2,596
2103	Year 76		$19,600,000	$700,643	$20,300,643	$2,707,884	24,000	3,201	19,000	2,534
2104	Year 77		$19,600,000	$886,252	$20,486,252	$2,667,888	24,000	3,125	19,000	2,474
2105	Year 78		$19,600,000	$1,109,875	$20,709,875	$2,633,100	24,000	3,051	19,000	2,416
2106	Year 79		$19,600,000	$1,376,090	$20,976,090	$2,603,749	24,000	2,979	19,000	2,358
2107	Year 80		$19,600,000	$30,109,067	$49,709,067	$6,024,138	24,000	2,909	19,000	2,303
2108	Year 81		$19,600,000	$2,052,884	$21,652,884	$2,561,886	24,000	2,840	19,000	2,248
2109	Year 82		$19,600,000	$2,470,070	$22,070,070	$2,549,368	24,000	2,772	19,000	2,195
2110	Year 83		$19,600,000	$3,281,648	$22,881,648	$2,580,483	24,000	2,707	19,000	2,143
2111	Year 84		$19,600,000	$3,470,318	$23,070,318	$2,540,107	24,000	2,642	19,000	2,092
2112	Year 85		$19,600,000	$4,052,143	$23,652,143	$2,542,457	24,000	2,580	19,000	2,042
2113	Year 86		$19,600,000	$4,684,439	$24,284,439	$2,548,567	24,000	2,519	19,000	1,994
2114	Year 87		$19,600,000	$5,361,511	$24,961,511	$2,557,547	24,000	2,459	19,000	1,947
2115	Year 88		$19,600,000	$6,101,316	$25,701,316	$2,570,945	24,000	2,401	19,000	1,901
2116	Year 89		$19,600,000	$6,815,818	$26,415,818	$2,579,801	24,000	2,344	19,000	1,856
2117	Year 90		$19,600,000	$16,797,289	$36,397,289	$3,470,372	24,000	2,288	19,000	1,812
2118	Year 91		$19,600,000	$8,664,046	$28,264,046	$2,631,032	24,000	2,234	19,000	1,769
2119	Year 92		$19,600,000	$9,063,414	$28,663,414	$2,604,980	24,000	2,181	19,000	1,727
2120	Year 93		$19,600,000	$9,769,310	$29,369,310	$2,605,884	24,000	2,129	19,000	1,686
2121	Year 94		$19,600,000	$10,425,408	$30,025,408	$2,600,968	24,000	2,079	19,000	1,646
2122	Year 95		$19,600,000	$11,014,866	$30,614,866	$2,589,185	24,000	2,030	19,000	1,607
2123	Year 96		$19,600,000	$11,547,784	$31,147,784	$2,571,833	24,000	1,982	19,000	1,569
2124	Year 97		$19,600,000	$11,932,262	$31,532,262	$2,541,882	24,000	1,935	19,000	1,532
2125	Year 98		$19,600,000	$12,234,329	$31,834,329	$2,505,421	24,000	1,889	19,000	1,495
2126	Year 99		$19,600,000	$12,758,416	$32,358,416	$2,486,321	24,000	1,844	19,000	1,460
2127	Year 100		$19,600,000	$229,804,032	$249,404,032	$18,709,324	24,000	1,800	19,000	1,425

Table 71. Life-cycle cost for Portfolio 1b

Portfolio 1b

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,100	$ 2,500	$ 1,700	$ 2,100	$ 200	200	$ 2,300	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,500	$ 3,100	$ 2,300	$ 2,800	$ 200	200	$ 2,700	$ 3,300

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	$630,000,000	$2,270,000,000	$1,210,000,000	$4,110,000,000	$1,495,000,000	2,400,000	742,000	1,980,000	612,000
	30-Yr Lifecycle:	$630,000,000	$685,000,000	$235,000,000	$1,545,000,000	$1,045,000,000	720,000	419,000	594,000	345,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$157,500,000		$0	$157,500,000	$139,702,566				
2025		$157,500,000		$0	$157,500,000	$136,392,079				
2026		$157,500,000		$0	$157,500,000	$133,160,039				
2027		$157,500,000		$0	$157,500,000	$130,004,588				
2028	Year 1		$22,700,000	$0	$22,700,000	$18,293,160	24,000	19,341	19,800	15,956
2029	Year 2		$22,700,000	$0	$22,700,000	$17,859,673	24,000	18,882	19,800	15,578
2030	Year 3		$22,700,000	$0	$22,700,000	$17,436,458	24,000	18,435	19,800	15,209
2031	Year 4		$22,700,000	$0	$22,700,000	$17,023,272	24,000	17,998	19,800	14,848
2032	Year 5		$22,700,000	$0	$22,700,000	$16,619,877	24,000	17,572	19,800	14,497
2033	Year 6		$22,700,000	$0	$22,700,000	$16,226,041	24,000	17,155	19,800	14,153
2034	Year 7		$22,700,000	$0	$22,700,000	$15,841,538	24,000	16,749	19,800	13,818
2035	Year 8		$22,700,000	$372,443	$23,072,443	$15,719,902	24,000	16,352	19,800	13,490
2036	Year 9		$22,700,000	$0	$22,700,000	$15,099,649	24,000	15,964	19,800	13,171
2037	Year 10		$22,700,000	$3,941,495	$26,641,495	$17,301,524	24,000	15,586	19,800	12,859
2038	Year 11		$22,700,000	$0	$22,700,000	$14,392,505	24,000	15,217	19,800	12,554
2039	Year 12		$22,700,000	$0	$22,700,000	$14,051,451	24,000	14,856	19,800	12,256
2040	Year 13		$22,700,000	$0	$22,700,000	$13,718,478	24,000	14,504	19,800	11,966
2041	Year 14		$22,700,000	$0	$22,700,000	$13,393,395	24,000	14,160	19,800	11,682
2042	Year 15		$22,700,000	$2,184,046	$24,884,046	$14,334,105	24,000	13,825	19,800	11,406
2043	Year 16		$22,700,000	$372,443	$23,072,443	$12,975,615	24,000	13,497	19,800	11,135
2044	Year 17		$22,700,000	$0	$22,700,000	$12,463,643	24,000	13,177	19,800	10,871
2045	Year 18		$22,700,000	$0	$22,700,000	$12,168,296	24,000	12,865	19,800	10,614
2046	Year 19		$22,700,000	$0	$22,700,000	$11,879,947	24,000	12,560	19,800	10,362
2047	Year 20		$22,700,000	$25,062,881	$47,762,881	$24,404,164	24,000	12,263	19,800	10,117
2048	Year 21		$22,700,000	$0	$22,700,000	$11,323,588	24,000	11,972	19,800	9,877

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2049	Year 22		$22,700,000	$0	$22,700,000	$11,055,256	24,000	11,688	19,800	9,643
2050	Year 23		$22,700,000	$0	$22,700,000	$10,793,283	24,000	11,411	19,800	9,414
2051	Year 24		$22,700,000	$372,443	$23,072,443	$10,710,409	24,000	11,141	19,800	9,191
2052	Year 25		$22,700,000	$187,950,373	$210,650,373	$95,468,364	24,000	10,877	19,800	8,974
2053	Year 26		$22,700,000	$0	$22,700,000	$10,044,027	24,000	10,619	19,800	8,761
2054	Year 27		$22,700,000	$0	$22,700,000	$9,806,017	24,000	10,368	19,800	8,553
2055	Year 28		$22,700,000	$0	$22,700,000	$9,573,647	24,000	10,122	19,800	8,351
2056	Year 29		$22,700,000	$0	$22,700,000	$9,346,783	24,000	9,882	19,800	8,153
2057	Year 30		$22,700,000	$12,546,113	$35,246,113	$14,168,775	24,000	9,648	19,800	7,960
2058	Year 31		$22,700,000	$0	$22,700,000	$8,909,056	24,000	9,419	19,800	7,771
2059	Year 32		$22,700,000	$25,927	$22,725,927	$8,707,875	24,000	9,196	19,800	7,587
2060	Year 33		$22,700,000	$346,516	$23,046,516	$8,621,457	24,000	8,978	19,800	7,407
2061	Year 34		$22,700,000	$0	$22,700,000	$8,290,601	24,000	8,765	19,800	7,231
2062	Year 35		$22,700,000	$0	$22,700,000	$8,094,141	24,000	8,558	19,800	7,060
2063	Year 36		$22,700,000	$0	$22,700,000	$7,902,337	24,000	8,355	19,800	6,893
2064	Year 37		$22,700,000	$0	$22,700,000	$7,715,077	24,000	8,157	19,800	6,729
2065	Year 38		$22,700,000	$0	$22,700,000	$7,532,256	24,000	7,964	19,800	6,570
2066	Year 39		$22,700,000	$0	$22,700,000	$7,353,766	24,000	7,775	19,800	6,414
2067	Year 40		$22,700,000	$28,369,550	$51,069,550	$16,152,165	24,000	7,591	19,800	6,262
2068	Year 41		$22,700,000	$346,516	$23,046,516	$7,116,374	24,000	7,411	19,800	6,114
2069	Year 42		$22,700,000	$0	$22,700,000	$6,843,277	24,000	7,235	19,800	5,969
2070	Year 43		$22,700,000	$0	$22,700,000	$6,681,114	24,000	7,064	19,800	5,828
2071	Year 44		$22,700,000	$0	$22,700,000	$6,522,794	24,000	6,896	19,800	5,689
2072	Year 45		$22,700,000	$2,184,046	$24,884,046	$6,980,934	24,000	6,733	19,800	5,555
2073	Year 46		$22,700,000	$0	$22,700,000	$6,217,319	24,000	6,573	19,800	5,423
2074	Year 47		$22,700,000	$0	$22,700,000	$6,069,989	24,000	6,418	19,800	5,295
2075	Year 48		$22,700,000	$25,927	$22,725,927	$5,932,919	24,000	6,266	19,800	5,169
2076	Year 49		$22,700,000	$346,516	$23,046,516	$5,874,040	24,000	6,117	19,800	5,047
2077	Year 50		$22,700,000	$233,717,090	$256,417,090	$63,806,268	24,000	5,972	19,800	4,927
2078	Year 51		$22,700,000	$0	$22,700,000	$5,514,765	24,000	5,831	19,800	4,810
2079	Year 52		$22,700,000	$0	$22,700,000	$5,384,083	24,000	5,692	19,800	4,696
2080	Year 53		$22,700,000	$0	$22,700,000	$5,256,498	24,000	5,558	19,800	4,585
2081	Year 54		$22,700,000	$0	$22,700,000	$5,131,937	24,000	5,426	19,800	4,476
2082	Year 55		$22,700,000	$0	$22,700,000	$5,010,327	24,000	5,297	19,800	4,370
2083	Year 56		$22,700,000	$25,927	$22,725,927	$4,897,186	24,000	5,172	19,800	4,267
2084	Year 57		$22,700,000	$0	$22,700,000	$4,775,684	24,000	5,049	19,800	4,166
2085	Year 58		$22,700,000	$346,516	$23,046,516	$4,733,690	24,000	4,930	19,800	4,067
2086	Year 59		$22,700,000	$0	$22,700,000	$4,552,030	24,000	4,813	19,800	3,970
2087	Year 60		$22,700,000	$33,185,509	$55,885,509	$10,941,157	24,000	4,699	19,800	3,876
2088	Year 61		$22,700,000	$4,044	$22,704,044	$4,339,623	24,000	4,587	19,800	3,785
2089	Year 62		$22,700,000	$5,943	$22,705,943	$4,237,143	24,000	4,479	19,800	3,695
2090	Year 63		$22,700,000	$8,650	$22,708,650	$4,137,230	24,000	4,372	19,800	3,607
2091	Year 64		$22,700,000	$38,384	$22,738,384	$4,044,480	24,000	4,269	19,800	3,522
2092	Year 65		$22,700,000	$17,767	$22,717,767	$3,945,059	24,000	4,168	19,800	3,438
2093	Year 66		$22,700,000	$371,603	$23,071,603	$3,911,564	24,000	4,069	19,800	3,357
2094	Year 67		$22,700,000	$35,071	$22,735,071	$3,763,169	24,000	3,973	19,800	3,277
2095	Year 68		$22,700,000	$48,539	$22,748,539	$3,676,171	24,000	3,878	19,800	3,200
2096	Year 69		$22,700,000	$66,511	$22,766,511	$3,591,893	24,000	3,787	19,800	3,124
2097	Year 70		$22,700,000	$5,420,314	$28,120,314	$4,331,435	24,000	3,697	19,800	3,050

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2098	Year 71		$22,700,000	$121,189	$22,821,189	$3,431,901	24,000	3,609	19,800	2,978
2099	Year 72		$22,700,000	$187,080	$22,887,080	$3,360,250	24,000	3,524	19,800	2,907
2100	Year 73		$22,700,000	$212,164	$22,912,164	$3,284,219	24,000	3,440	19,800	2,838
2101	Year 74		$22,700,000	$623,056	$23,323,056	$3,263,895	24,000	3,359	19,800	2,771
2102	Year 75		$22,700,000	$245,336,738	$268,036,738	$36,620,968	24,000	3,279	19,800	2,705
2103	Year 76		$22,700,000	$455,938	$23,155,938	$3,088,749	24,000	3,201	19,800	2,641
2104	Year 77		$22,700,000	$576,721	$23,276,721	$3,031,285	24,000	3,125	19,800	2,579
2105	Year 78		$22,700,000	$722,241	$23,422,241	$2,977,956	24,000	3,051	19,800	2,517
2106	Year 79		$22,700,000	$895,478	$23,595,478	$2,928,892	24,000	2,979	19,800	2,458
2107	Year 80		$22,700,000	$28,984,058	$51,684,058	$6,263,483	24,000	2,909	19,800	2,400
2108	Year 81		$22,700,000	$1,335,895	$24,035,895	$2,843,835	24,000	2,840	19,800	2,343
2109	Year 82		$22,700,000	$1,607,375	$24,307,375	$2,807,805	24,000	2,772	19,800	2,287
2110	Year 83		$22,700,000	$2,261,294	$24,961,294	$2,815,015	24,000	2,707	19,800	2,233
2111	Year 84		$22,700,000	$2,258,277	$24,958,277	$2,747,976	24,000	2,642	19,800	2,180
2112	Year 85		$22,700,000	$2,636,894	$25,336,894	$2,723,557	24,000	2,580	19,800	2,128
2113	Year 86		$22,700,000	$3,048,354	$25,748,354	$2,702,199	24,000	2,519	19,800	2,078
2114	Year 87		$22,700,000	$3,488,953	$26,188,953	$2,683,310	24,000	2,459	19,800	2,029
2115	Year 88		$22,700,000	$3,979,431	$26,679,431	$2,668,788	24,000	2,401	19,800	1,981
2116	Year 89		$22,700,000	$4,435,330	$27,135,330	$2,650,070	24,000	2,344	19,800	1,934
2117	Year 90		$22,700,000	$17,149,486	$39,849,486	$3,799,528	24,000	2,288	19,800	1,888
2118	Year 91		$22,700,000	$5,763,839	$28,463,839	$2,649,630	24,000	2,234	19,800	1,843
2119	Year 92		$22,700,000	$5,897,934	$28,597,934	$2,599,029	24,000	2,181	19,800	1,799
2120	Year 93		$22,700,000	$6,357,289	$29,057,289	$2,578,199	24,000	2,129	19,800	1,757
2121	Year 94		$22,700,000	$6,784,238	$29,484,238	$2,554,089	24,000	2,079	19,800	1,715
2122	Year 95		$22,700,000	$7,167,822	$29,867,822	$2,526,006	24,000	2,030	19,800	1,675
2123	Year 96		$22,700,000	$7,523,669	$30,223,669	$2,495,530	24,000	1,982	19,800	1,635
2124	Year 97		$22,700,000	$7,764,809	$30,464,809	$2,455,833	24,000	1,935	19,800	1,596
2125	Year 98		$22,700,000	$7,961,376	$30,661,376	$2,413,108	24,000	1,889	19,800	1,558
2126	Year 99		$22,700,000	$8,428,212	$31,128,212	$2,391,795	24,000	1,844	19,800	1,521
2127	Year 100		$22,700,000	$283,405,275	$306,105,275	$22,962,832	24,000	1,800	19,800	1,485

Table 72. Life-cycle cost for Portfolio 1c

Portfolio 1c

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 1,900	$ 1,900	$ 1,600	$ 1,600	$ 200	200	$ 2,100	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,300	$ 2,300	$ 2,100	$ 2,100	$ 200	200	$ 2,500	$ 2,500

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	$535,000,000	$2,230,000,000	$1,170,000,000	$3,935,000,000	$1,395,000,000	2,400,000	742,000	2,400,000	742,000
	30-Yr Lifecycle:	$535,000,000	$670,000,000	$230,000,000	$1,435,000,000	$955,000,000	720,000	419,000	720,000	419,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$133,750,000		$0	$133,750,000	$118,636,306				
2025		$133,750,000		$0	$133,750,000	$115,825,019				
2026		$133,750,000		$0	$133,750,000	$113,080,351				
2027		$133,750,000		$0	$133,750,000	$110,400,721				
2028	Year 1		$22,300,000	$0	$22,300,000	$17,970,814	24,000	19,341	24,000	19,341
2029	Year 2		$22,300,000	$0	$22,300,000	$17,544,965	24,000	18,882	24,000	18,882
2030	Year 3		$22,300,000	$0	$22,300,000	$17,129,208	24,000	18,435	24,000	18,435
2031	Year 4		$22,300,000	$0	$22,300,000	$16,723,302	24,000	17,998	24,000	17,998
2032	Year 5		$22,300,000	$0	$22,300,000	$16,327,016	24,000	17,572	24,000	17,572
2033	Year 6		$22,300,000	$0	$22,300,000	$15,940,120	24,000	17,155	24,000	17,155
2034	Year 7		$22,300,000	$0	$22,300,000	$15,562,392	24,000	16,749	24,000	16,749
2035	Year 8		$22,300,000	$365,116	$22,665,116	$15,442,378	24,000	16,352	24,000	16,352
2036	Year 9		$22,300,000	$0	$22,300,000	$14,833,576	24,000	15,964	24,000	15,964
2037	Year 10		$22,300,000	$2,752,528	$25,052,528	$16,269,617	24,000	15,586	24,000	15,586
2038	Year 11		$22,300,000	$0	$22,300,000	$14,138,893	24,000	15,217	24,000	15,217
2039	Year 12		$22,300,000	$0	$22,300,000	$13,803,848	24,000	14,856	24,000	14,856
2040	Year 13		$22,300,000	$0	$22,300,000	$13,476,742	24,000	14,504	24,000	14,504
2041	Year 14		$22,300,000	$0	$22,300,000	$13,157,388	24,000	14,160	24,000	14,160
2042	Year 15		$22,300,000	$2,184,046	$24,484,046	$14,103,691	24,000	13,825	24,000	13,825
2043	Year 16		$22,300,000	$365,116	$22,665,116	$12,746,540	24,000	13,497	24,000	13,497
2044	Year 17		$22,300,000	$0	$22,300,000	$12,244,019	24,000	13,177	24,000	13,177
2045	Year 18		$22,300,000	$0	$22,300,000	$11,953,876	24,000	12,865	24,000	12,865
2046	Year 19		$22,300,000	$0	$22,300,000	$11,670,609	24,000	12,560	24,000	12,560
2047	Year 20		$22,300,000	$21,209,840	$43,509,840	$22,231,098	24,000	12,263	24,000	12,263

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2048	Year 21		$22,300,000	$0	$22,300,000	$11,124,053	24,000	11,972	24,000	11,972
2049	Year 22		$22,300,000	$0	$22,300,000	$10,860,450	24,000	11,688	24,000	11,688
2050	Year 23		$22,300,000	$0	$22,300,000	$10,603,093	24,000	11,411	24,000	11,411
2051	Year 24		$22,300,000	$365,116	$22,665,116	$10,521,325	24,000	11,141	24,000	11,141
2052	Year 25		$22,300,000	$190,975,335	$213,275,335	$96,658,017	24,000	10,877	24,000	10,877
2053	Year 26		$22,300,000	$0	$22,300,000	$9,867,040	24,000	10,619	24,000	10,619
2054	Year 27		$22,300,000	$0	$22,300,000	$9,633,224	24,000	10,368	24,000	10,368
2055	Year 28		$22,300,000	$0	$22,300,000	$9,404,948	24,000	10,122	24,000	10,122
2056	Year 29		$22,300,000	$0	$22,300,000	$9,182,082	24,000	9,882	24,000	9,882
2057	Year 30		$22,300,000	$9,860,068	$32,160,068	$12,928,199	24,000	9,648	24,000	9,648
2058	Year 31		$22,300,000	$0	$22,300,000	$8,752,068	24,000	9,419	24,000	9,419
2059	Year 32		$22,300,000	$25,927	$22,325,927	$8,554,608	24,000	9,196	24,000	9,196
2060	Year 33		$22,300,000	$339,189	$22,639,189	$8,469,080	24,000	8,978	24,000	8,978
2061	Year 34		$22,300,000	$0	$22,300,000	$8,144,511	24,000	8,765	24,000	8,765
2062	Year 35		$22,300,000	$0	$22,300,000	$7,951,513	24,000	8,558	24,000	8,558
2063	Year 36		$22,300,000	$0	$22,300,000	$7,763,088	24,000	8,355	24,000	8,355
2064	Year 37		$22,300,000	$0	$22,300,000	$7,579,129	24,000	8,157	24,000	8,157
2065	Year 38		$22,300,000	$0	$22,300,000	$7,399,529	24,000	7,964	24,000	7,964
2066	Year 39		$22,300,000	$0	$22,300,000	$7,224,184	24,000	7,775	24,000	7,775
2067	Year 40		$22,300,000	$24,516,509	$46,816,509	$14,807,023	24,000	7,591	24,000	7,591
2068	Year 41		$22,300,000	$339,189	$22,639,189	$6,990,598	24,000	7,411	24,000	7,411
2069	Year 42		$22,300,000	$0	$22,300,000	$6,722,690	24,000	7,235	24,000	7,235
2070	Year 43		$22,300,000	$0	$22,300,000	$6,563,385	24,000	7,064	24,000	7,064
2071	Year 44		$22,300,000	$0	$22,300,000	$6,407,855	24,000	6,896	24,000	6,896
2072	Year 45		$22,300,000	$2,184,046	$24,484,046	$6,868,719	24,000	6,733	24,000	6,733
2073	Year 46		$22,300,000	$0	$22,300,000	$6,107,763	24,000	6,573	24,000	6,573
2074	Year 47		$22,300,000	$0	$22,300,000	$5,963,029	24,000	6,418	24,000	6,418
2075	Year 48		$22,300,000	$25,927	$22,325,927	$5,828,494	24,000	6,266	24,000	6,266
2076	Year 49		$22,300,000	$339,189	$22,639,189	$5,770,221	24,000	6,117	24,000	6,117
2077	Year 50		$22,300,000	$236,546,354	$258,846,354	$64,410,760	24,000	5,972	24,000	5,972
2078	Year 51		$22,300,000	$0	$22,300,000	$5,417,588	24,000	5,831	24,000	5,831
2079	Year 52		$22,300,000	$0	$22,300,000	$5,289,209	24,000	5,692	24,000	5,692
2080	Year 53		$22,300,000	$0	$22,300,000	$5,163,873	24,000	5,558	24,000	5,558
2081	Year 54		$22,300,000	$0	$22,300,000	$5,041,506	24,000	5,426	24,000	5,426
2082	Year 55		$22,300,000	$0	$22,300,000	$4,922,039	24,000	5,297	24,000	5,297
2083	Year 56		$22,300,000	$25,927	$22,325,927	$4,810,990	24,000	5,172	24,000	5,172
2084	Year 57		$22,300,000	$0	$22,300,000	$4,691,531	24,000	5,049	24,000	5,049
2085	Year 58		$22,300,000	$339,189	$22,639,189	$4,650,026	24,000	4,930	24,000	4,930
2086	Year 59		$22,300,000	$0	$22,300,000	$4,471,818	24,000	4,813	24,000	4,813
2087	Year 60		$22,300,000	$27,777,158	$50,077,158	$9,804,009	24,000	4,699	24,000	4,699
2088	Year 61		$22,300,000	$2,665	$22,302,665	$4,262,904	24,000	4,587	24,000	4,587
2089	Year 62		$22,300,000	$3,919	$22,303,919	$4,162,121	24,000	4,479	24,000	4,479
2090	Year 63		$22,300,000	$5,704	$22,305,704	$4,063,818	24,000	4,372	24,000	4,372
2091	Year 64		$22,300,000	$34,142	$22,334,142	$3,972,577	24,000	4,269	24,000	4,269
2092	Year 65		$22,300,000	$11,716	$22,311,716	$3,874,546	24,000	4,168	24,000	4,168
2093	Year 66		$22,300,000	$355,732	$22,655,732	$3,841,057	24,000	4,069	24,000	4,069
2094	Year 67		$22,300,000	$23,126	$22,323,126	$3,694,983	24,000	3,973	24,000	3,973
2095	Year 68		$22,300,000	$32,007	$22,332,007	$3,608,859	24,000	3,878	24,000	3,878
2096	Year 69		$22,300,000	$43,860	$22,343,860	$3,525,211	24,000	3,787	24,000	3,787

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2097	Year 70		$22,300,000	$4,257,920	$26,557,920	$4,090,776	24,000	3,697	24,000	3,697
2098	Year 71		$22,300,000	$79,914	$22,379,914	$3,365,541	24,000	3,609	24,000	3,609
2099	Year 72		$22,300,000	$132,194	$22,432,194	$3,293,464	24,000	3,524	24,000	3,524
2100	Year 73		$22,300,000	$139,906	$22,439,906	$3,216,526	24,000	3,440	24,000	3,440
2101	Year 74		$22,300,000	$521,544	$22,821,544	$3,193,712	24,000	3,359	24,000	3,359
2102	Year 75		$22,300,000	$248,172,220	$270,472,220	$36,953,720	24,000	3,279	24,000	3,279
2103	Year 76		$22,300,000	$300,655	$22,600,655	$3,014,681	24,000	3,201	24,000	3,201
2104	Year 77		$22,300,000	$380,302	$22,680,302	$2,953,615	24,000	3,125	24,000	3,125
2105	Year 78		$22,300,000	$476,261	$22,776,261	$2,895,824	24,000	3,051	24,000	3,051
2106	Year 79		$22,300,000	$590,497	$22,890,497	$2,841,383	24,000	2,979	24,000	2,979
2107	Year 80		$22,300,000	$24,699,340	$46,999,340	$5,695,752	24,000	2,909	24,000	2,909
2108	Year 81		$22,300,000	$880,918	$23,180,918	$2,742,677	24,000	2,840	24,000	2,840
2109	Year 82		$22,300,000	$1,059,937	$23,359,937	$2,698,364	24,000	2,772	24,000	2,772
2110	Year 83		$22,300,000	$1,601,833	$23,901,833	$2,695,534	24,000	2,707	24,000	2,707
2111	Year 84		$22,300,000	$1,489,156	$23,789,156	$2,619,253	24,000	2,642	24,000	2,642
2112	Year 85		$22,300,000	$1,738,823	$24,038,823	$2,584,023	24,000	2,580	24,000	2,580
2113	Year 86		$22,300,000	$2,010,148	$24,310,148	$2,551,265	24,000	2,519	24,000	2,519
2114	Year 87		$22,300,000	$2,300,688	$24,600,688	$2,520,577	24,000	2,459	24,000	2,459
2115	Year 88		$22,300,000	$2,632,949	$24,932,949	$2,494,084	24,000	2,401	24,000	2,401
2116	Year 89		$22,300,000	$2,924,749	$25,224,749	$2,463,480	24,000	2,344	24,000	2,344
2117	Year 90		$22,300,000	$12,612,735	$34,912,735	$3,328,824	24,000	2,288	24,000	2,288
2118	Year 91		$22,300,000	$3,911,484	$26,211,484	$2,439,964	24,000	2,234	24,000	2,234
2119	Year 92		$22,300,000	$3,889,221	$26,189,221	$2,380,121	24,000	2,181	24,000	2,181
2120	Year 93		$22,300,000	$4,192,128	$26,492,128	$2,350,597	24,000	2,129	24,000	2,129
2121	Year 94		$22,300,000	$4,473,668	$26,773,668	$2,319,284	24,000	2,079	24,000	2,079
2122	Year 95		$22,300,000	$4,726,611	$27,026,611	$2,285,717	24,000	2,030	24,000	2,030
2123	Year 96		$22,300,000	$4,970,094	$27,270,094	$2,251,657	24,000	1,982	24,000	1,982
2124	Year 97		$22,300,000	$5,120,277	$27,420,277	$2,210,407	24,000	1,935	24,000	1,935
2125	Year 98		$22,300,000	$5,249,897	$27,549,897	$2,168,229	24,000	1,889	24,000	1,889
2126	Year 99		$22,300,000	$5,668,428	$27,968,428	$2,149,007	24,000	1,844	24,000	1,844
2127	Year 100		$22,300,000	$295,310,257	$317,610,257	$23,825,891	24,000	1,800	24,000	1,800

Table 73. Life-cycle cost for Portfolio 1d

Portfolio 1d

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,000	$ 2,000	$ 1,700	$ 1,700	$ 200	200	$ 2,200	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,400	$ 2,400	$ 2,200	$ 2,200	$ 200	200	$ 2,600	$ 2,600

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	$585,000,000	$2,230,000,000	$1,200,000,000	$4,015,000,000	$1,440,000,000	2,400,000	742,000	2,400,000	742,000
	30-Yr Lifecycle:	$585,000,000	$670,000,000	$230,000,000	$1,485,000,000	$1,000,000,000	720,000	419,000	720,000	419,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$146,250,000		$0	$146,250,000	$129,723,811				
2025		$146,250,000		$0	$146,250,000	$126,649,787				
2026		$146,250,000		$0	$146,250,000	$123,648,608				
2027		$146,250,000		$0	$146,250,000	$120,718,546				
2028	Year 1		$22,300,000	$0	$22,300,000	$17,970,814	24,000	19,341	24,000	19,341
2029	Year 2		$22,300,000	$0	$22,300,000	$17,544,965	24,000	18,882	24,000	18,882
2030	Year 3		$22,300,000	$0	$22,300,000	$17,129,208	24,000	18,435	24,000	18,435
2031	Year 4		$22,300,000	$0	$22,300,000	$16,723,302	24,000	17,998	24,000	17,998
2032	Year 5		$22,300,000	$0	$22,300,000	$16,327,016	24,000	17,572	24,000	17,572
2033	Year 6		$22,300,000	$0	$22,300,000	$15,940,120	24,000	17,155	24,000	17,155
2034	Year 7		$22,300,000	$0	$22,300,000	$15,562,392	24,000	16,749	24,000	16,749
2035	Year 8		$22,300,000	$365,116	$22,665,116	$15,442,378	24,000	16,352	24,000	16,352
2036	Year 9		$22,300,000	$0	$22,300,000	$14,833,576	24,000	15,964	24,000	15,964
2037	Year 10		$22,300,000	$2,752,528	$25,052,528	$16,269,617	24,000	15,586	24,000	15,586
2038	Year 11		$22,300,000	$0	$22,300,000	$14,138,893	24,000	15,217	24,000	15,217
2039	Year 12		$22,300,000	$0	$22,300,000	$13,803,848	24,000	14,856	24,000	14,856
2040	Year 13		$22,300,000	$0	$22,300,000	$13,476,742	24,000	14,504	24,000	14,504
2041	Year 14		$22,300,000	$0	$22,300,000	$13,157,388	24,000	14,160	24,000	14,160
2042	Year 15		$22,300,000	$2,184,046	$24,484,046	$14,103,691	24,000	13,825	24,000	13,825
2043	Year 16		$22,300,000	$365,116	$22,665,116	$12,746,540	24,000	13,497	24,000	13,497
2044	Year 17		$22,300,000	$0	$22,300,000	$12,244,019	24,000	13,177	24,000	13,177
2045	Year 18		$22,300,000	$0	$22,300,000	$11,953,876	24,000	12,865	24,000	12,865
2046	Year 19		$22,300,000	$0	$22,300,000	$11,670,609	24,000	12,560	24,000	12,560
2047	Year 20		$22,300,000	$22,870,382	$45,170,382	$23,079,542	24,000	12,263	24,000	12,263
2048	Year 21		$22,300,000	$0	$22,300,000	$11,124,053	24,000	11,972	24,000	11,972

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2049	Year 22		$22,300,000	$0	$22,300,000	$10,860,450	24,000	11,688	24,000	11,688
2050	Year 23		$22,300,000	$0	$22,300,000	$10,603,093	24,000	11,411	24,000	11,411
2051	Year 24		$22,300,000	$365,116	$22,665,116	$10,521,325	24,000	11,141	24,000	11,141
2052	Year 25		$22,300,000	$190,975,335	$213,275,335	$96,658,017	24,000	10,877	24,000	10,877
2053	Year 26		$22,300,000	$0	$22,300,000	$9,867,040	24,000	10,619	24,000	10,619
2054	Year 27		$22,300,000	$0	$22,300,000	$9,633,224	24,000	10,368	24,000	10,368
2055	Year 28		$22,300,000	$0	$22,300,000	$9,404,948	24,000	10,122	24,000	10,122
2056	Year 29		$22,300,000	$0	$22,300,000	$9,182,082	24,000	9,882	24,000	9,882
2057	Year 30		$22,300,000	$9,860,068	$32,160,068	$12,928,199	24,000	9,648	24,000	9,648
2058	Year 31		$22,300,000	$0	$22,300,000	$8,752,068	24,000	9,419	24,000	9,419
2059	Year 32		$22,300,000	$25,927	$22,325,927	$8,554,608	24,000	9,196	24,000	9,196
2060	Year 33		$22,300,000	$339,189	$22,639,189	$8,469,080	24,000	8,978	24,000	8,978
2061	Year 34		$22,300,000	$0	$22,300,000	$8,144,511	24,000	8,765	24,000	8,765
2062	Year 35		$22,300,000	$0	$22,300,000	$7,951,513	24,000	8,558	24,000	8,558
2063	Year 36		$22,300,000	$0	$22,300,000	$7,763,088	24,000	8,355	24,000	8,355
2064	Year 37		$22,300,000	$0	$22,300,000	$7,579,129	24,000	8,157	24,000	8,157
2065	Year 38		$22,300,000	$0	$22,300,000	$7,399,529	24,000	7,964	24,000	7,964
2066	Year 39		$22,300,000	$0	$22,300,000	$7,224,184	24,000	7,775	24,000	7,775
2067	Year 40		$22,300,000	$26,177,051	$48,477,051	$15,332,215	24,000	7,591	24,000	7,591
2068	Year 41		$22,300,000	$339,189	$22,639,189	$6,990,598	24,000	7,411	24,000	7,411
2069	Year 42		$22,300,000	$0	$22,300,000	$6,722,690	24,000	7,235	24,000	7,235
2070	Year 43		$22,300,000	$0	$22,300,000	$6,563,385	24,000	7,064	24,000	7,064
2071	Year 44		$22,300,000	$0	$22,300,000	$6,407,855	24,000	6,896	24,000	6,896
2072	Year 45		$22,300,000	$2,184,046	$24,484,046	$6,868,719	24,000	6,733	24,000	6,733
2073	Year 46		$22,300,000	$0	$22,300,000	$6,107,763	24,000	6,573	24,000	6,573
2074	Year 47		$22,300,000	$0	$22,300,000	$5,963,029	24,000	6,418	24,000	6,418
2075	Year 48		$22,300,000	$25,927	$22,325,927	$5,828,494	24,000	6,266	24,000	6,266
2076	Year 49		$22,300,000	$339,189	$22,639,189	$5,770,221	24,000	6,117	24,000	6,117
2077	Year 50		$22,300,000	$236,546,354	$258,846,354	$64,410,760	24,000	5,972	24,000	5,972
2078	Year 51		$22,300,000	$0	$22,300,000	$5,417,588	24,000	5,831	24,000	5,831
2079	Year 52		$22,300,000	$0	$22,300,000	$5,289,209	24,000	5,692	24,000	5,692
2080	Year 53		$22,300,000	$0	$22,300,000	$5,163,873	24,000	5,558	24,000	5,558
2081	Year 54		$22,300,000	$0	$22,300,000	$5,041,506	24,000	5,426	24,000	5,426
2082	Year 55		$22,300,000	$0	$22,300,000	$4,922,039	24,000	5,297	24,000	5,297
2083	Year 56		$22,300,000	$25,927	$22,325,927	$4,810,990	24,000	5,172	24,000	5,172
2084	Year 57		$22,300,000	$0	$22,300,000	$4,691,531	24,000	5,049	24,000	5,049
2085	Year 58		$22,300,000	$339,189	$22,639,189	$4,650,026	24,000	4,930	24,000	4,930
2086	Year 59		$22,300,000	$0	$22,300,000	$4,471,818	24,000	4,813	24,000	4,813
2087	Year 60		$22,300,000	$29,438,256	$51,738,256	$10,129,215	24,000	4,699	24,000	4,699
2088	Year 61		$22,300,000	$3,490	$22,303,490	$4,263,062	24,000	4,587	24,000	4,587
2089	Year 62		$22,300,000	$5,131	$22,305,131	$4,162,347	24,000	4,479	24,000	4,479
2090	Year 63		$22,300,000	$7,467	$22,307,467	$4,064,139	24,000	4,372	24,000	4,372
2091	Year 64		$22,300,000	$36,682	$22,336,682	$3,973,029	24,000	4,269	24,000	4,269
2092	Year 65		$22,300,000	$15,339	$22,315,339	$3,875,175	24,000	4,168	24,000	4,168
2093	Year 66		$22,300,000	$360,848	$22,660,848	$3,841,924	24,000	4,069	24,000	4,069
2094	Year 67		$22,300,000	$30,277	$22,330,277	$3,696,166	24,000	3,973	24,000	3,973
2095	Year 68		$22,300,000	$41,905	$22,341,905	$3,610,458	24,000	3,878	24,000	3,878
2096	Year 69		$22,300,000	$57,422	$22,357,422	$3,527,351	24,000	3,787	24,000	3,787
2097	Year 70		$22,300,000	$4,276,318	$26,576,318	$4,093,610	24,000	3,697	24,000	3,697

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, exlcuding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2098	Year 71		$22,300,000	$104,625	$22,404,625	$3,369,257	24,000	3,609	24,000	3,609
2099	Year 72		$22,300,000	$165,054	$22,465,054	$3,298,289	24,000	3,524	24,000	3,524
2100	Year 73		$22,300,000	$183,167	$22,483,167	$3,222,727	24,000	3,440	24,000	3,440
2101	Year 74		$22,300,000	$577,932	$22,877,932	$3,201,603	24,000	3,359	24,000	3,359
2102	Year 75		$22,300,000	$248,244,986	$270,544,986	$36,963,662	24,000	3,279	24,000	3,279
2103	Year 76		$22,300,000	$393,622	$22,693,622	$3,027,081	24,000	3,201	24,000	3,201
2104	Year 77		$22,300,000	$497,898	$22,797,898	$2,968,929	24,000	3,125	24,000	3,125
2105	Year 78		$22,300,000	$623,528	$22,923,528	$2,914,548	24,000	3,051	24,000	3,051
2106	Year 79		$22,300,000	$773,089	$23,073,089	$2,864,048	24,000	2,979	24,000	2,979
2107	Year 80		$22,300,000	$26,584,018	$48,884,018	$5,924,152	24,000	2,909	24,000	2,909
2108	Year 81		$22,300,000	$1,153,312	$23,453,312	$2,774,906	24,000	2,840	24,000	2,840
2109	Year 82		$22,300,000	$1,387,687	$23,687,687	$2,736,223	24,000	2,772	24,000	2,772
2110	Year 83		$22,300,000	$1,992,264	$24,292,264	$2,739,565	24,000	2,707	24,000	2,707
2111	Year 84		$22,300,000	$1,949,628	$24,249,628	$2,669,952	24,000	2,642	24,000	2,642
2112	Year 85		$22,300,000	$2,276,496	$24,576,496	$2,641,819	24,000	2,580	24,000	2,580
2113	Year 86		$22,300,000	$2,631,720	$24,931,720	$2,616,496	24,000	2,519	24,000	2,519
2114	Year 87		$22,300,000	$3,012,100	$25,312,100	$2,593,468	24,000	2,459	24,000	2,459
2115	Year 88		$22,300,000	$3,439,085	$25,739,085	$2,574,723	24,000	2,401	24,000	2,401
2116	Year 89		$22,300,000	$3,829,131	$26,129,131	$2,551,803	24,000	2,344	24,000	2,344
2117	Year 90		$22,300,000	$13,617,241	$35,917,241	$3,424,601	24,000	2,288	24,000	2,288
2118	Year 91		$22,300,000	$5,016,099	$27,316,099	$2,542,790	24,000	2,234	24,000	2,234
2119	Year 92		$22,300,000	$5,091,833	$27,391,833	$2,489,417	24,000	2,181	24,000	2,181
2120	Year 93		$22,300,000	$5,488,405	$27,788,405	$2,465,613	24,000	2,129	24,000	2,129
2121	Year 94		$22,300,000	$5,857,002	$28,157,002	$2,439,116	24,000	2,079	24,000	2,079
2122	Year 95		$22,300,000	$6,188,159	$28,488,159	$2,409,324	24,000	2,030	24,000	2,030
2123	Year 96		$22,300,000	$6,498,915	$28,798,915	$2,377,890	24,000	1,982	24,000	1,982
2124	Year 97		$22,300,000	$6,703,553	$29,003,553	$2,338,038	24,000	1,935	24,000	1,935
2125	Year 98		$22,300,000	$6,873,255	$29,173,255	$2,295,990	24,000	1,889	24,000	1,889
2126	Year 99		$22,300,000	$7,316,319	$29,616,319	$2,275,626	24,000	1,844	24,000	1,844
2127	Year 100		$22,300,000	$296,966,408	$319,266,408	$23,950,129	24,000	1,800	24,000	1,800

Table 74. Life-cycle cost for Portfolio 2a

Portfolio 2a

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,200	$ 2,900	$ 1,900	$ 2,500	$ 200	200	$ 2,400	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,800	$ 3,800	$ 2,600	$ 3,500	$ 200	200	$ 3,000	$ 4,000

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	$765,000,000	$2,090,000,000	$1,135,000,000	$3,990,000,000	$1,525,000,000	2,300,000	711,000	1,700,000	526,000
	30-Yr Lifecycle:	$765,000,000	$630,000,000	$195,000,000	$1,590,000,000	$1,110,000,000	690,000	401,000	510,000	297,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$191,250,000		$0	$191,250,000	$169,638,830				
2025		$191,250,000		$0	$191,250,000	$165,618,953				
2026		$191,250,000		$0	$191,250,000	$161,694,333				
2027		$191,250,000		$0	$191,250,000	$157,862,714				
2028	Year 1		$20,900,000	$0	$20,900,000	$16,842,601	23,000	18,535	17,000	13,700
2029	Year 2		$20,900,000	$0	$20,900,000	$16,443,488	23,000	18,096	17,000	13,375
2030	Year 3		$20,900,000	$0	$20,900,000	$16,053,832	23,000	17,667	17,000	13,058
2031	Year 4		$20,900,000	$0	$20,900,000	$15,673,409	23,000	17,248	17,000	12,749
2032	Year 5		$20,900,000	$0	$20,900,000	$15,302,001	23,000	16,840	17,000	12,447
2033	Year 6		$20,900,000	$0	$20,900,000	$14,939,395	23,000	16,440	17,000	12,152
2034	Year 7		$20,900,000	$0	$20,900,000	$14,585,380	23,000	16,051	17,000	11,864
2035	Year 8		$20,900,000	$365,116	$21,265,116	$14,488,519	23,000	15,671	17,000	11,583
2036	Year 9		$20,900,000	$0	$20,900,000	$13,902,320	23,000	15,299	17,000	11,308
2037	Year 10		$20,900,000	$2,712,446	$23,612,446	$15,334,399	23,000	14,937	17,000	11,040
2038	Year 11		$20,900,000	$0	$20,900,000	$13,251,249	23,000	14,583	17,000	10,779
2039	Year 12		$20,900,000	$0	$20,900,000	$12,937,239	23,000	14,237	17,000	10,523
2040	Year 13		$20,900,000	$0	$20,900,000	$12,630,669	23,000	13,900	17,000	10,274
2041	Year 14		$20,900,000	$0	$20,900,000	$12,331,364	23,000	13,570	17,000	10,030
2042	Year 15		$20,900,000	$1,024,213	$21,924,213	$12,629,135	23,000	13,249	17,000	9,793
2043	Year 16		$20,900,000	$365,116	$21,265,116	$11,959,200	23,000	12,935	17,000	9,561
2044	Year 17		$20,900,000	$0	$20,900,000	$11,475,336	23,000	12,628	17,000	9,334
2045	Year 18		$20,900,000	$0	$20,900,000	$11,203,409	23,000	12,329	17,000	9,113
2046	Year 19		$20,900,000	$0	$20,900,000	$10,937,925	23,000	12,037	17,000	8,897
2047	Year 20		$20,900,000	$30,377,222	$51,277,222	$26,199,796	23,000	11,752	17,000	8,686
2048	Year 21		$20,900,000	$0	$20,900,000	$10,425,682	23,000	11,473	17,000	8,480

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2049	Year 22		$20,900,000	$0	$20,900,000	$10,178,628	23,000	11,201	17,000	8,279
2050	Year 23		$20,900,000	$0	$20,900,000	$9,937,428	23,000	10,936	17,000	8,083
2051	Year 24		$20,900,000	$365,116	$21,265,116	$9,871,434	23,000	10,677	17,000	7,892
2052	Year 25		$20,900,000	$150,273,619	$171,173,619	$77,577,196	23,000	10,424	17,000	7,705
2053	Year 26		$20,900,000	$0	$20,900,000	$9,247,584	23,000	10,177	17,000	7,522
2054	Year 27		$20,900,000	$0	$20,900,000	$9,028,447	23,000	9,936	17,000	7,344
2055	Year 28		$20,900,000	$0	$20,900,000	$8,814,503	23,000	9,700	17,000	7,170
2056	Year 29		$20,900,000	$0	$20,900,000	$8,605,628	23,000	9,470	17,000	7,000
2057	Year 30		$20,900,000	$8,758,155	$29,658,155	$11,922,442	23,000	9,246	17,000	6,834
2058	Year 31		$20,900,000	$0	$20,900,000	$8,202,611	23,000	9,027	17,000	6,672
2059	Year 32		$20,900,000	$25,927	$20,925,927	$8,018,171	23,000	8,813	17,000	6,514
2060	Year 33		$20,900,000	$339,189	$21,239,189	$7,945,355	23,000	8,604	17,000	6,360
2061	Year 34		$20,900,000	$0	$20,900,000	$7,633,196	23,000	8,400	17,000	6,209
2062	Year 35		$20,900,000	$0	$20,900,000	$7,452,315	23,000	8,201	17,000	6,062
2063	Year 36		$20,900,000	$0	$20,900,000	$7,275,720	23,000	8,007	17,000	5,918
2064	Year 37		$20,900,000	$0	$20,900,000	$7,103,309	23,000	7,817	17,000	5,778
2065	Year 38		$20,900,000	$0	$20,900,000	$6,934,984	23,000	7,632	17,000	5,641
2066	Year 39		$20,900,000	$0	$20,900,000	$6,770,648	23,000	7,451	17,000	5,507
2067	Year 40		$20,900,000	$33,683,891	$54,583,891	$17,263,673	23,000	7,274	17,000	5,377
2068	Year 41		$20,900,000	$339,189	$21,239,189	$6,558,302	23,000	7,102	17,000	5,249
2069	Year 42		$20,900,000	$0	$20,900,000	$6,300,638	23,000	6,934	17,000	5,125
2070	Year 43		$20,900,000	$0	$20,900,000	$6,151,334	23,000	6,769	17,000	5,003
2071	Year 44		$20,900,000	$0	$20,900,000	$6,005,568	23,000	6,609	17,000	4,885
2072	Year 45		$20,900,000	$1,024,213	$21,924,213	$6,150,587	23,000	6,452	17,000	4,769
2073	Year 46		$20,900,000	$0	$20,900,000	$5,724,316	23,000	6,299	17,000	4,656
2074	Year 47		$20,900,000	$0	$20,900,000	$5,588,669	23,000	6,150	17,000	4,546
2075	Year 48		$20,900,000	$25,927	$20,925,927	$5,463,004	23,000	6,004	17,000	4,438
2076	Year 49		$20,900,000	$339,189	$21,239,189	$5,413,393	23,000	5,862	17,000	4,333
2077	Year 50		$20,900,000	$186,433,699	$207,333,699	$51,592,464	23,000	5,723	17,000	4,230
2078	Year 51		$20,900,000	$0	$20,900,000	$5,077,471	23,000	5,588	17,000	4,130
2079	Year 52		$20,900,000	$0	$20,900,000	$4,957,151	23,000	5,455	17,000	4,032
2080	Year 53		$20,900,000	$0	$20,900,000	$4,839,683	23,000	5,326	17,000	3,937
2081	Year 54		$20,900,000	$0	$20,900,000	$4,724,999	23,000	5,200	17,000	3,843
2082	Year 55		$20,900,000	$0	$20,900,000	$4,613,032	23,000	5,077	17,000	3,752
2083	Year 56		$20,900,000	$25,927	$20,925,927	$4,509,306	23,000	4,956	17,000	3,663
2084	Year 57		$20,900,000	$0	$20,900,000	$4,396,995	23,000	4,839	17,000	3,577
2085	Year 58		$20,900,000	$339,189	$21,239,189	$4,362,470	23,000	4,724	17,000	3,492
2086	Year 59		$20,900,000	$0	$20,900,000	$4,191,076	23,000	4,612	17,000	3,409
2087	Year 60		$20,900,000	$35,829,215	$56,729,215	$11,106,336	23,000	4,503	17,000	3,328
2088	Year 61		$20,900,000	$8,323	$20,908,323	$3,996,391	23,000	4,396	17,000	3,249
2089	Year 62		$20,900,000	$12,230	$20,912,230	$3,902,419	23,000	4,292	17,000	3,172
2090	Year 63		$20,900,000	$17,797	$20,917,797	$3,810,959	23,000	4,190	17,000	3,097
2091	Year 64		$20,900,000	$51,563	$20,951,563	$3,726,658	23,000	4,091	17,000	3,024
2092	Year 65		$20,900,000	$36,560	$20,936,560	$3,635,743	23,000	3,994	17,000	2,952
2093	Year 66		$20,900,000	$390,813	$21,290,813	$3,609,648	23,000	3,899	17,000	2,882
2094	Year 67		$20,900,000	$72,166	$20,972,166	$3,471,368	23,000	3,807	17,000	2,814
2095	Year 68		$20,900,000	$99,880	$20,999,880	$3,393,587	23,000	3,717	17,000	2,747
2096	Year 69		$20,900,000	$136,859	$21,036,859	$3,319,004	23,000	3,629	17,000	2,682
2097	Year 70		$20,900,000	$4,401,314	$25,301,314	$3,897,218	23,000	3,543	17,000	2,619

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2098	Year 71		$20,900,000	$249,376	$21,149,376	$3,180,490	23,000	3,459	17,000	2,556
2099	Year 72		$20,900,000	$357,537	$21,257,537	$3,121,003	23,000	3,377	17,000	2,496
2100	Year 73		$20,900,000	$436,576	$21,336,576	$3,058,375	23,000	3,297	17,000	2,437
2101	Year 74		$20,900,000	$908,234	$21,808,234	$3,051,907	23,000	3,219	17,000	2,379
2102	Year 75		$20,900,000	$192,187,867	$213,087,867	$29,113,487	23,000	3,142	17,000	2,323
2103	Year 76		$20,900,000	$938,199	$21,838,199	$2,912,977	23,000	3,068	17,000	2,268
2104	Year 77		$20,900,000	$1,186,736	$22,086,736	$2,876,316	23,000	2,995	17,000	2,214
2105	Year 78		$20,900,000	$1,486,177	$22,386,177	$2,846,228	23,000	2,924	17,000	2,161
2106	Year 79		$20,900,000	$1,842,652	$22,742,652	$2,823,031	23,000	2,855	17,000	2,110
2107	Year 80		$20,900,000	$35,346,471	$56,246,471	$6,816,393	23,000	2,787	17,000	2,060
2108	Year 81		$20,900,000	$2,748,915	$23,648,915	$2,798,049	23,000	2,721	17,000	2,011
2109	Year 82		$20,900,000	$3,307,547	$24,207,547	$2,796,273	23,000	2,657	17,000	1,964
2110	Year 83		$20,900,000	$4,279,290	$25,179,290	$2,839,600	23,000	2,594	17,000	1,917
2111	Year 84		$20,900,000	$4,646,930	$25,546,930	$2,812,789	23,000	2,532	17,000	1,872
2112	Year 85		$20,900,000	$5,426,024	$26,326,024	$2,829,883	23,000	2,472	17,000	1,827
2113	Year 86		$20,900,000	$6,272,699	$27,172,699	$2,851,679	23,000	2,414	17,000	1,784
2114	Year 87		$20,900,000	$7,179,333	$28,079,333	$2,876,997	23,000	2,357	17,000	1,742
2115	Year 88		$20,900,000	$8,161,179	$29,061,179	$2,907,038	23,000	2,301	17,000	1,701
2116	Year 89		$20,900,000	$9,126,723	$30,026,723	$2,932,447	23,000	2,246	17,000	1,660
2117	Year 90		$20,900,000	$18,810,606	$39,710,606	$3,786,287	23,000	2,193	17,000	1,621
2118	Year 91		$20,900,000	$11,486,594	$32,386,594	$3,014,790	23,000	2,141	17,000	1,582
2119	Year 92		$20,900,000	$12,136,368	$33,036,368	$3,002,402	23,000	2,090	17,000	1,545
2120	Year 93		$20,900,000	$13,081,599	$33,981,599	$3,015,123	23,000	2,041	17,000	1,508
2121	Year 94		$20,900,000	$13,960,149	$34,860,149	$3,019,780	23,000	1,992	17,000	1,473
2122	Year 95		$20,900,000	$14,749,463	$35,649,463	$3,014,976	23,000	1,945	17,000	1,438
2123	Year 96		$20,900,000	$15,454,277	$36,354,277	$3,001,726	23,000	1,899	17,000	1,404
2124	Year 97		$20,900,000	$15,977,903	$36,877,903	$2,972,806	23,000	1,854	17,000	1,370
2125	Year 98		$20,900,000	$16,382,384	$37,282,384	$2,934,194	23,000	1,810	17,000	1,338
2126	Year 99		$20,900,000	$16,969,163	$37,869,163	$2,909,749	23,000	1,767	17,000	1,306
2127	Year 100		$20,900,000	$241,287,767	$262,187,767	$19,668,310	23,000	1,725	17,000	1,275

Table 75. Life-cycle cost for Portfolio 2b

Portfolio 2b

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,200	$ 2,900	$ 1,800	$ 2,500	$ 200	200	$ 2,400	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 2,800	$ 3,700	$ 2,600	$ 3,400	$ 200	200	$ 3,000	$ 3,900

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
100-Yr Lifecycle:		$765,000,000	$2,000,000,000	$1,110,000,000	$3,875,000,000	$1,495,000,000	2,300,000	711,000	1,700,000	526,000
30-Yr Lifecycle:		$765,000,000	$600,000,000	$195,000,000	$1,560,000,000	$1,095,000,000	690,000	401,000	510,000	297,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$191,250,000		$0	$191,250,000	$169,638,830				
2025		$191,250,000		$0	$191,250,000	$165,618,953				
2026		$191,250,000		$0	$191,250,000	$161,694,333				
2027		$191,250,000		$0	$191,250,000	$157,862,714				
2028	Year 1		$20,000,000	$0	$20,000,000	$16,117,322	23,000	18,535	17,000	13,700
2029	Year 2		$20,000,000	$0	$20,000,000	$15,735,395	23,000	18,096	17,000	13,375
2030	Year 3		$20,000,000	$0	$20,000,000	$15,362,518	23,000	17,667	17,000	13,058
2031	Year 4		$20,000,000	$0	$20,000,000	$14,998,478	23,000	17,248	17,000	12,749
2032	Year 5		$20,000,000	$0	$20,000,000	$14,643,063	23,000	16,840	17,000	12,447
2033	Year 6		$20,000,000	$0	$20,000,000	$14,296,071	23,000	16,440	17,000	12,152
2034	Year 7		$20,000,000	$0	$20,000,000	$13,957,302	23,000	16,051	17,000	11,864
2035	Year 8		$20,000,000	$365,116	$20,365,116	$13,875,324	23,000	15,671	17,000	11,583
2036	Year 9		$20,000,000	$0	$20,000,000	$13,303,656	23,000	15,299	17,000	11,308
2037	Year 10		$20,000,000	$2,457,762	$22,457,762	$14,584,524	23,000	14,937	17,000	11,040
2038	Year 11		$20,000,000	$0	$20,000,000	$12,680,621	23,000	14,583	17,000	10,779
2039	Year 12		$20,000,000	$0	$20,000,000	$12,380,133	23,000	14,237	17,000	10,523
2040	Year 13		$20,000,000	$0	$20,000,000	$12,086,765	23,000	13,900	17,000	10,274
2041	Year 14		$20,000,000	$0	$20,000,000	$11,800,348	23,000	13,570	17,000	10,030
2042	Year 15		$20,000,000	$1,024,213	$21,024,213	$12,110,703	23,000	13,249	17,000	9,793
2043	Year 16		$20,000,000	$365,116	$20,365,116	$11,453,052	23,000	12,935	17,000	9,561
2044	Year 17		$20,000,000	$0	$20,000,000	$10,981,183	23,000	12,628	17,000	9,334
2045	Year 18		$20,000,000	$0	$20,000,000	$10,720,965	23,000	12,329	17,000	9,113
2046	Year 19		$20,000,000	$0	$20,000,000	$10,466,914	23,000	12,037	17,000	8,897

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2047	Year 20		$20,000,000	$28,752,711	$48,752,711	$24,909,912	23,000	11,752	17,000	8,686
2048	Year 21		$20,000,000	$0	$20,000,000	$9,976,729	23,000	11,473	17,000	8,480
2049	Year 22		$20,000,000	$0	$20,000,000	$9,740,314	23,000	11,201	17,000	8,279
2050	Year 23		$20,000,000	$0	$20,000,000	$9,509,501	23,000	10,936	17,000	8,083
2051	Year 24		$20,000,000	$365,116	$20,365,116	$9,453,647	23,000	10,677	17,000	7,892
2052	Year 25		$20,000,000	$148,650,898	$168,650,898	$76,433,880	23,000	10,424	17,000	7,705
2053	Year 26		$20,000,000	$0	$20,000,000	$8,849,363	23,000	10,177	17,000	7,522
2054	Year 27		$20,000,000	$0	$20,000,000	$8,639,662	23,000	9,936	17,000	7,344
2055	Year 28		$20,000,000	$0	$20,000,000	$8,434,931	23,000	9,700	17,000	7,170
2056	Year 29		$20,000,000	$0	$20,000,000	$8,235,051	23,000	9,470	17,000	7,000
2057	Year 30		$20,000,000	$8,600,315	$28,600,315	$11,497,195	23,000	9,246	17,000	6,834
2058	Year 31		$20,000,000	$0	$20,000,000	$7,849,389	23,000	9,027	17,000	6,672
2059	Year 32		$20,000,000	$25,927	$20,025,927	$7,673,319	23,000	8,813	17,000	6,514
2060	Year 33		$20,000,000	$339,189	$20,339,189	$7,608,674	23,000	8,604	17,000	6,360
2061	Year 34		$20,000,000	$0	$20,000,000	$7,304,494	23,000	8,400	17,000	6,209
2062	Year 35		$20,000,000	$0	$20,000,000	$7,131,402	23,000	8,201	17,000	6,062
2063	Year 36		$20,000,000	$0	$20,000,000	$6,962,411	23,000	8,007	17,000	5,918
2064	Year 37		$20,000,000	$0	$20,000,000	$6,797,425	23,000	7,817	17,000	5,778
2065	Year 38		$20,000,000	$0	$20,000,000	$6,636,349	23,000	7,632	17,000	5,641
2066	Year 39		$20,000,000	$0	$20,000,000	$6,479,089	23,000	7,451	17,000	5,507
2067	Year 40		$20,000,000	$32,059,380	$52,059,380	$16,465,227	23,000	7,274	17,000	5,377
2068	Year 41		$20,000,000	$339,189	$20,339,189	$6,280,397	23,000	7,102	17,000	5,249
2069	Year 42		$20,000,000	$0	$20,000,000	$6,029,319	23,000	6,934	17,000	5,125
2070	Year 43		$20,000,000	$0	$20,000,000	$5,886,444	23,000	6,769	17,000	5,003
2071	Year 44		$20,000,000	$0	$20,000,000	$5,746,955	23,000	6,609	17,000	4,885
2072	Year 45		$20,000,000	$1,024,213	$21,024,213	$5,898,102	23,000	6,452	17,000	4,769
2073	Year 46		$20,000,000	$0	$20,000,000	$5,477,814	23,000	6,299	17,000	4,656
2074	Year 47		$20,000,000	$0	$20,000,000	$5,348,008	23,000	6,150	17,000	4,546
2075	Year 48		$20,000,000	$25,927	$20,025,927	$5,228,047	23,000	6,004	17,000	4,438
2076	Year 49		$20,000,000	$339,189	$20,339,189	$5,184,003	23,000	5,862	17,000	4,333
2077	Year 50		$20,000,000	$183,919,583	$203,919,583	$50,742,903	23,000	5,723	17,000	4,230
2078	Year 51		$20,000,000	$0	$20,000,000	$4,858,824	23,000	5,588	17,000	4,130
2079	Year 52		$20,000,000	$0	$20,000,000	$4,743,686	23,000	5,455	17,000	4,032
2080	Year 53		$20,000,000	$0	$20,000,000	$4,631,276	23,000	5,326	17,000	3,937
2081	Year 54		$20,000,000	$0	$20,000,000	$4,521,530	23,000	5,200	17,000	3,843
2082	Year 55		$20,000,000	$0	$20,000,000	$4,414,385	23,000	5,077	17,000	3,752
2083	Year 56		$20,000,000	$25,927	$20,025,927	$4,315,366	23,000	4,956	17,000	3,663
2084	Year 57		$20,000,000	$0	$20,000,000	$4,207,651	23,000	4,839	17,000	3,577
2085	Year 58		$20,000,000	$339,189	$20,339,189	$4,177,612	23,000	4,724	17,000	3,492
2086	Year 59		$20,000,000	$0	$20,000,000	$4,010,599	23,000	4,612	17,000	3,409
2087	Year 60		$20,000,000	$34,358,410	$54,358,410	$10,642,184	23,000	4,503	17,000	3,328
2088	Year 61		$20,000,000	$7,667	$20,007,667	$3,824,241	23,000	4,396	17,000	3,249
2089	Year 62		$20,000,000	$11,267	$20,011,267	$3,734,291	23,000	4,292	17,000	3,172
2090	Year 63		$20,000,000	$16,394	$20,016,394	$3,646,735	23,000	4,190	17,000	3,097
2091	Year 64		$20,000,000	$49,543	$20,049,543	$3,566,215	23,000	4,091	17,000	3,024
2092	Year 65		$20,000,000	$33,680	$20,033,680	$3,478,953	23,000	3,994	17,000	2,952
2093	Year 66		$20,000,000	$386,746	$20,386,746	$3,456,372	23,000	3,899	17,000	2,882

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2094	Year 67		$20,000,000	$66,480	$20,066,480	$3,321,457	23,000	3,807	17,000	2,814
2095	Year 68		$20,000,000	$92,011	$20,092,011	$3,246,875	23,000	3,717	17,000	2,747
2096	Year 69		$20,000,000	$126,078	$20,126,078	$3,175,309	23,000	3,629	17,000	2,682
2097	Year 70		$20,000,000	$4,074,699	$24,074,699	$3,708,280	23,000	3,543	17,000	2,619
2098	Year 71		$20,000,000	$229,731	$20,229,731	$3,042,191	23,000	3,459	17,000	2,556
2099	Year 72		$20,000,000	$331,414	$20,331,414	$2,985,031	23,000	3,377	17,000	2,496
2100	Year 73		$20,000,000	$402,182	$20,402,182	$2,924,439	23,000	3,297	17,000	2,437
2101	Year 74		$20,000,000	$863,405	$20,863,405	$2,919,685	23,000	3,219	17,000	2,379
2102	Year 75		$20,000,000	$199,201,966	$219,201,966	$29,948,836	23,000	3,142	17,000	2,323
2103	Year 76		$20,000,000	$864,287	$20,864,287	$2,783,068	23,000	3,068	17,000	2,268
2104	Year 77		$20,000,000	$1,093,247	$21,093,247	$2,746,936	23,000	2,995	17,000	2,214
2105	Year 78		$20,000,000	$1,369,097	$21,369,097	$2,716,914	23,000	2,924	17,000	2,161
2106	Year 79		$20,000,000	$1,697,490	$21,697,490	$2,693,296	23,000	2,855	17,000	2,110
2107	Year 80		$20,000,000	$33,601,073	$53,601,073	$6,495,802	23,000	2,787	17,000	2,060
2108	Year 81		$20,000,000	$2,532,357	$22,532,357	$2,665,942	23,000	2,721	17,000	2,011
2109	Year 82		$20,000,000	$3,046,980	$23,046,980	$2,662,213	23,000	2,657	17,000	1,964
2110	Year 83		$20,000,000	$3,968,891	$23,968,891	$2,703,097	23,000	2,594	17,000	1,917
2111	Year 84		$20,000,000	$4,280,847	$24,280,847	$2,673,389	23,000	2,532	17,000	1,872
2112	Year 85		$20,000,000	$4,998,564	$24,998,564	$2,687,189	23,000	2,472	17,000	1,827
2113	Year 86		$20,000,000	$5,778,538	$25,778,538	$2,705,367	23,000	2,414	17,000	1,784
2114	Year 87		$20,000,000	$6,613,749	$26,613,749	$2,726,834	23,000	2,357	17,000	1,742
2115	Year 88		$20,000,000	$7,520,287	$27,520,287	$2,752,900	23,000	2,301	17,000	1,701
2116	Year 89		$20,000,000	$8,407,724	$28,407,724	$2,774,333	23,000	2,246	17,000	1,660
2117	Year 90		$20,000,000	$17,700,018	$37,700,018	$3,594,583	23,000	2,193	17,000	1,621
2118	Year 91		$20,000,000	$10,608,405	$30,608,405	$2,849,262	23,000	2,141	17,000	1,582
2119	Year 92		$20,000,000	$11,180,269	$31,180,269	$2,833,716	23,000	2,090	17,000	1,545
2120	Year 93		$20,000,000	$12,051,036	$32,051,036	$2,843,828	23,000	2,041	17,000	1,508
2121	Year 94		$20,000,000	$12,860,374	$32,860,374	$2,846,548	23,000	1,992	17,000	1,473
2122	Year 95		$20,000,000	$13,587,506	$33,587,506	$2,840,590	23,000	1,945	17,000	1,438
2123	Year 96		$20,000,000	$14,238,837	$34,238,837	$2,827,057	23,000	1,899	17,000	1,404
2124	Year 97		$20,000,000	$14,719,169	$34,719,169	$2,798,786	23,000	1,854	17,000	1,370
2125	Year 98		$20,000,000	$15,091,785	$35,091,785	$2,761,789	23,000	1,810	17,000	1,338
2126	Year 99		$20,000,000	$15,659,059	$35,659,059	$2,739,932	23,000	1,767	17,000	1,306
2127	Year 100		$20,000,000	$233,329,182	$253,329,182	$19,003,774	23,000	1,725	17,000	1,275

Table 76. Life-cycle cost for Portfolio 4

Portfolio 4

Summary of Lifecycle Unit Costs ($/AF)

Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,300	$ 3,100	$ 2,000	$ 2,600	$ 200	200	$ 2,500	Lifecycle Unit Cost ($/AF), no R&R
30-Yr Lifecycle:	$ 3,000	$ 4,000	$ 2,700	$ 3,600	$ 200	300	$ 3,200	$ 4,300

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
100-Yr Lifecycle:		$805,000,000	$2,140,000,000	$1,235,000,000	$4,180,000,000	$1,605,000,000	2,300,000	711,000	1,700,000	526,000
30-Yr Lifecycle:		$805,000,000	$645,000,000	$225,000,000	$1,670,000,000	$1,170,000,000	690,000	401,000	510,000	297,000
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$201,250,000		$0	$201,250,000	$178,508,834				
2025		$201,250,000		$0	$201,250,000	$174,278,767				
2026		$201,250,000		$0	$201,250,000	$170,148,939				
2027		$201,250,000		$0	$201,250,000	$166,116,973				
2028	Year 1		$21,400,000	$0	$21,400,000	$17,245,534	23,000	18,535	17,000	13,700
2029	Year 2		$21,400,000	$0	$21,400,000	$16,836,873	23,000	18,096	17,000	13,375
2030	Year 3		$21,400,000	$0	$21,400,000	$16,437,895	23,000	17,667	17,000	13,058
2031	Year 4		$21,400,000	$0	$21,400,000	$16,048,371	23,000	17,248	17,000	12,749
2032	Year 5		$21,400,000	$0	$21,400,000	$15,668,078	23,000	16,840	17,000	12,447
2033	Year 6		$21,400,000	$0	$21,400,000	$15,296,796	23,000	16,440	17,000	12,152
2034	Year 7		$21,400,000	$0	$21,400,000	$14,934,313	23,000	16,051	17,000	11,864
2035	Year 8		$21,400,000	$554,855	$21,954,855	$14,958,458	23,000	15,671	17,000	11,583
2036	Year 9		$21,400,000	$0	$21,400,000	$14,234,912	23,000	15,299	17,000	11,308
2037	Year 10		$21,400,000	$3,932,052	$25,332,052	$16,451,145	23,000	14,937	17,000	11,040
2038	Year 11		$21,400,000	$0	$21,400,000	$13,568,265	23,000	14,583	17,000	10,779
2039	Year 12		$21,400,000	$0	$21,400,000	$13,246,742	23,000	14,237	17,000	10,523
2040	Year 13		$21,400,000	$0	$21,400,000	$12,932,838	23,000	13,900	17,000	10,274
2041	Year 14		$21,400,000	$0	$21,400,000	$12,626,373	23,000	13,570	17,000	10,030
2042	Year 15		$21,400,000	$1,169,282	$22,569,282	$13,000,718	23,000	13,249	17,000	9,793
2043	Year 16		$21,400,000	$554,855	$21,954,855	$12,347,099	23,000	12,935	17,000	9,561
2044	Year 17		$21,400,000	$0	$21,400,000	$11,749,866	23,000	12,628	17,000	9,334
2045	Year 18		$21,400,000	$0	$21,400,000	$11,471,433	23,000	12,329	17,000	9,113
2046	Year 19		$21,400,000	$0	$21,400,000	$11,199,598	23,000	12,037	17,000	8,897
2047	Year 20		$21,400,000	$31,022,033	$52,422,033	$26,784,731	23,000	11,752	17,000	8,686

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2048	Year 21		$21,400,000	$0	$21,400,000	$10,675,100	23,000	11,473	17,000	8,480
2049	Year 22		$21,400,000	$0	$21,400,000	$10,422,136	23,000	11,201	17,000	8,279
2050	Year 23		$21,400,000	$0	$21,400,000	$10,175,166	23,000	10,936	17,000	8,083
2051	Year 24		$21,400,000	$554,855	$21,954,855	$10,191,616	23,000	10,677	17,000	7,892
2052	Year 25		$21,400,000	$172,703,861	$194,103,861	$87,969,358	23,000	10,424	17,000	7,705
2053	Year 26		$21,400,000	$0	$21,400,000	$9,468,818	23,000	10,177	17,000	7,522
2054	Year 27		$21,400,000	$0	$21,400,000	$9,244,439	23,000	9,936	17,000	7,344
2055	Year 28		$21,400,000	$0	$21,400,000	$9,025,376	23,000	9,700	17,000	7,170
2056	Year 29		$21,400,000	$0	$21,400,000	$8,811,505	23,000	9,470	17,000	7,000
2057	Year 30		$21,400,000	$11,324,086	$32,724,086	$13,154,932	23,000	9,246	17,000	6,834
2058	Year 31		$21,400,000	$0	$21,400,000	$8,398,846	23,000	9,027	17,000	6,672
2059	Year 32		$21,400,000	$38,916	$21,438,916	$8,214,732	23,000	8,813	17,000	6,514
2060	Year 33		$21,400,000	$515,939	$21,915,939	$8,198,520	23,000	8,604	17,000	6,360
2061	Year 34		$21,400,000	$0	$21,400,000	$7,815,808	23,000	8,400	17,000	6,209
2062	Year 35		$21,400,000	$0	$21,400,000	$7,630,600	23,000	8,201	17,000	6,062
2063	Year 36		$21,400,000	$0	$21,400,000	$7,449,780	23,000	8,007	17,000	5,918
2064	Year 37		$21,400,000	$0	$21,400,000	$7,273,245	23,000	7,817	17,000	5,778
2065	Year 38		$21,400,000	$0	$21,400,000	$7,100,893	23,000	7,632	17,000	5,641
2066	Year 39		$21,400,000	$0	$21,400,000	$6,932,625	23,000	7,451	17,000	5,507
2067	Year 40		$21,400,000	$37,570,682	$58,970,682	$18,651,118	23,000	7,274	17,000	5,377
2068	Year 41		$21,400,000	$515,939	$21,915,939	$6,767,271	23,000	7,102	17,000	5,249
2069	Year 42		$21,400,000	$0	$21,400,000	$6,451,371	23,000	6,934	17,000	5,125
2070	Year 43		$21,400,000	$0	$21,400,000	$6,298,495	23,000	6,769	17,000	5,003
2071	Year 44		$21,400,000	$0	$21,400,000	$6,149,242	23,000	6,609	17,000	4,885
2072	Year 45		$21,400,000	$1,169,282	$22,569,282	$6,331,554	23,000	6,452	17,000	4,769
2073	Year 46		$21,400,000	$0	$21,400,000	$5,861,261	23,000	6,299	17,000	4,656
2074	Year 47		$21,400,000	$0	$21,400,000	$5,722,369	23,000	6,150	17,000	4,546
2075	Year 48		$21,400,000	$38,916	$21,438,916	$5,596,927	23,000	6,004	17,000	4,438
2076	Year 49		$21,400,000	$515,939	$21,915,939	$5,585,881	23,000	5,862	17,000	4,333
2077	Year 50		$21,400,000	$213,688,286	$235,088,286	$58,498,855	23,000	5,723	17,000	4,230
2078	Year 51		$21,400,000	$0	$21,400,000	$5,198,941	23,000	5,588	17,000	4,130
2079	Year 52		$21,400,000	$0	$21,400,000	$5,075,744	23,000	5,455	17,000	4,032
2080	Year 53		$21,400,000	$0	$21,400,000	$4,955,465	23,000	5,326	17,000	3,937
2081	Year 54		$21,400,000	$0	$21,400,000	$4,838,037	23,000	5,200	17,000	3,843
2082	Year 55		$21,400,000	$0	$21,400,000	$4,723,392	23,000	5,077	17,000	3,752
2083	Year 56		$21,400,000	$38,916	$21,438,916	$4,619,849	23,000	4,956	17,000	3,663
2084	Year 57		$21,400,000	$0	$21,400,000	$4,502,187	23,000	4,839	17,000	3,577
2085	Year 58		$21,400,000	$515,939	$21,915,939	$4,501,472	23,000	4,724	17,000	3,492
2086	Year 59		$21,400,000	$0	$21,400,000	$4,291,341	23,000	4,612	17,000	3,409
2087	Year 60		$21,400,000	$37,879,336	$59,279,336	$11,605,594	23,000	4,503	17,000	3,328
2088	Year 61		$21,400,000	$6,963	$21,406,963	$4,091,701	23,000	4,396	17,000	3,249
2089	Year 62		$21,400,000	$10,234	$21,410,234	$3,995,351	23,000	4,292	17,000	3,172
2090	Year 63		$21,400,000	$14,889	$21,414,889	$3,901,523	23,000	4,190	17,000	3,097
2091	Year 64		$21,400,000	$60,366	$21,460,366	$3,817,159	23,000	4,091	17,000	3,024
2092	Year 65		$21,400,000	$30,588	$21,430,588	$3,721,534	23,000	3,994	17,000	2,952
2093	Year 66		$21,400,000	$559,131	$21,959,131	$3,722,955	23,000	3,899	17,000	2,882
2094	Year 67		$21,400,000	$60,380	$21,460,380	$3,552,179	23,000	3,807	17,000	2,814
2095	Year 68		$21,400,000	$83,567	$21,483,567	$3,471,751	23,000	3,717	17,000	2,747

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2096	Year 69		$21,400,000	$114,508	$21,514,508	$3,394,363	23,000	3,629	17,000	2,682
2097	Year 70		$21,400,000	$5,578,321	$26,978,321	$4,155,532	23,000	3,543	17,000	2,619
2098	Year 71		$21,400,000	$208,649	$21,608,649	$3,249,556	23,000	3,459	17,000	2,556
2099	Year 72		$21,400,000	$316,369	$21,716,369	$3,188,368	23,000	3,377	17,000	2,496
2100	Year 73		$21,400,000	$365,274	$21,765,274	$3,119,824	23,000	3,297	17,000	2,437
2101	Year 74		$21,400,000	$992,050	$22,392,050	$3,133,607	23,000	3,219	17,000	2,379
2102	Year 75		$21,400,000	$228,963,137	$250,363,137	$34,206,283	23,000	3,142	17,000	2,323
2103	Year 76		$21,400,000	$784,975	$22,184,975	$2,959,233	23,000	3,068	17,000	2,268
2104	Year 77		$21,400,000	$992,923	$22,392,923	$2,916,190	23,000	2,995	17,000	2,214
2105	Year 78		$21,400,000	$1,243,460	$22,643,460	$2,878,940	23,000	2,924	17,000	2,161
2106	Year 79		$21,400,000	$1,541,717	$22,941,717	$2,847,741	23,000	2,855	17,000	2,110
2107	Year 80		$21,400,000	$38,923,755	$60,323,755	$7,310,510	23,000	2,787	17,000	2,060
2108	Year 81		$21,400,000	$2,299,970	$23,699,970	$2,804,090	23,000	2,721	17,000	2,011
2109	Year 82		$21,400,000	$2,767,368	$24,167,368	$2,791,632	23,000	2,657	17,000	1,964
2110	Year 83		$21,400,000	$3,812,553	$25,212,553	$2,843,351	23,000	2,594	17,000	1,917
2111	Year 84		$21,400,000	$3,888,006	$25,288,006	$2,784,280	23,000	2,532	17,000	1,872
2112	Year 85		$21,400,000	$4,539,862	$25,939,862	$2,788,373	23,000	2,472	17,000	1,827
2113	Year 86		$21,400,000	$5,248,263	$26,648,263	$2,796,642	23,000	2,414	17,000	1,784
2114	Year 87		$21,400,000	$6,006,827	$27,406,827	$2,808,093	23,000	2,357	17,000	1,742
2115	Year 88		$21,400,000	$6,845,544	$28,245,544	$2,825,448	23,000	2,301	17,000	1,701
2116	Year 89		$21,400,000	$7,636,174	$29,036,174	$2,835,709	23,000	2,246	17,000	1,660
2117	Year 90		$21,400,000	$19,079,562	$40,479,562	$3,859,604	23,000	2,193	17,000	1,621
2118	Year 91		$21,400,000	$9,842,782	$31,242,782	$2,908,315	23,000	2,141	17,000	1,582
2119	Year 92		$21,400,000	$10,154,294	$31,554,294	$2,867,708	23,000	2,090	17,000	1,545
2120	Year 93		$21,400,000	$10,945,153	$32,345,153	$2,869,925	23,000	2,041	17,000	1,508
2121	Year 94		$21,400,000	$11,680,217	$33,080,217	$2,865,592	23,000	1,992	17,000	1,473
2122	Year 95		$21,400,000	$12,340,626	$33,740,626	$2,853,540	23,000	1,945	17,000	1,438
2123	Year 96		$21,400,000	$12,947,555	$34,347,555	$2,836,034	23,000	1,899	17,000	1,404
2124	Year 97		$21,400,000	$13,368,441	$34,768,441	$2,802,758	23,000	1,854	17,000	1,370
2125	Year 98		$21,400,000	$13,706,862	$35,106,862	$2,762,976	23,000	1,810	17,000	1,338
2126	Year 99		$21,400,000	$14,429,957	$35,829,957	$2,753,063	23,000	1,767	17,000	1,306
2127	Year 100		$21,400,000	$266,766,105	$288,166,105	$21,617,105	23,000	1,725	17,000	1,275

Table 77. Life-cycle cost for Morgan Hill Option 1 (NPR+ from SBWR)

Morgan Hill - Option 1

Summary of Lifecycle Unit Costs ($/AF)				
Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 1,700	$ 1,600	$ -	$ 1,700
30-Yr Lifecycle:	$ 2,200	$ 2,200	$ -	$ 2,200

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	$70,000,000	$260,000,000	$20,000,000	$350,000,000	$145,000,000	290,000	90,000
	30-Yr Lifecycle:	$70,000,000	$80,000,000	$5,000,000	$150,000,000	$110,000,000	87,000	51,000
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$17,500,000		$0	$17,500,000	$15,522,507		
2025		$17,500,000		$0	$17,500,000	$15,154,675		
2026		$17,500,000		$0	$17,500,000	$14,795,560		
2027		$17,500,000		$0	$17,500,000	$14,444,954		
2028	Year 1		$2,600,000	$0	$2,600,000	$2,095,252	2,900	2,337
2029	Year 2		$2,600,000	$0	$2,600,000	$2,045,601	2,900	2,282
2030	Year 3		$2,600,000	$0	$2,600,000	$1,997,127	2,900	2,228
2031	Year 4		$2,600,000	$0	$2,600,000	$1,949,802	2,900	2,175
2032	Year 5		$2,600,000	$0	$2,600,000	$1,903,598	2,900	2,123
2033	Year 6		$2,600,000	$0	$2,600,000	$1,858,489	2,900	2,073
2034	Year 7		$2,600,000	$0	$2,600,000	$1,814,449	2,900	2,024
2035	Year 8		$2,600,000	$0	$2,600,000	$1,771,453	2,900	1,976
2036	Year 9		$2,600,000	$0	$2,600,000	$1,729,475	2,900	1,929
2037	Year 10		$2,600,000	$0	$2,600,000	$1,688,492	2,900	1,883
2038	Year 11		$2,600,000	$0	$2,600,000	$1,648,481	2,900	1,839
2039	Year 12		$2,600,000	$0	$2,600,000	$1,609,417	2,900	1,795
2040	Year 13		$2,600,000	$0	$2,600,000	$1,571,279	2,900	1,753
2041	Year 14		$2,600,000	$0	$2,600,000	$1,534,045	2,900	1,711
2042	Year 15		$2,600,000	$0	$2,600,000	$1,497,693	2,900	1,671
2043	Year 16		$2,600,000	$0	$2,600,000	$1,462,203	2,900	1,631
2044	Year 17		$2,600,000	$0	$2,600,000	$1,427,554	2,900	1,592
2045	Year 18		$2,600,000	$0	$2,600,000	$1,393,725	2,900	1,555
2046	Year 19		$2,600,000	$0	$2,600,000	$1,360,699	2,900	1,518
2047	Year 20		$2,600,000	$1,034,018	$3,634,018	$1,856,780	2,900	1,482
2048	Year 21		$2,600,000	$0	$2,600,000	$1,296,975	2,900	1,447
2049	Year 22		$2,600,000	$0	$2,600,000	$1,266,241	2,900	1,412
2050	Year 23		$2,600,000	$0	$2,600,000	$1,236,235	2,900	1,379
2051	Year 24		$2,600,000	$0	$2,600,000	$1,206,940	2,900	1,346

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2052	Year 25		$2,600,000	$0	$2,600,000	$1,178,340	2,900	1,314
2053	Year 26		$2,600,000	$0	$2,600,000	$1,150,417	2,900	1,283
2054	Year 27		$2,600,000	$0	$2,600,000	$1,123,156	2,900	1,253
2055	Year 28		$2,600,000	$0	$2,600,000	$1,096,541	2,900	1,223
2056	Year 29		$2,600,000	$0	$2,600,000	$1,070,557	2,900	1,194
2057	Year 30		$2,600,000	$0	$2,600,000	$1,045,188	2,900	1,166
2058	Year 31		$2,600,000	$0	$2,600,000	$1,020,421	2,900	1,138
2059	Year 32		$2,600,000	$0	$2,600,000	$996,240	2,900	1,111
2060	Year 33		$2,600,000	$0	$2,600,000	$972,632	2,900	1,085
2061	Year 34		$2,600,000	$0	$2,600,000	$949,584	2,900	1,059
2062	Year 35		$2,600,000	$0	$2,600,000	$927,082	2,900	1,034
2063	Year 36		$2,600,000	$0	$2,600,000	$905,113	2,900	1,010
2064	Year 37		$2,600,000	$0	$2,600,000	$883,665	2,900	986
2065	Year 38		$2,600,000	$0	$2,600,000	$862,725	2,900	962
2066	Year 39		$2,600,000	$0	$2,600,000	$842,282	2,900	939
2067	Year 40		$2,600,000	$1,034,018	$3,634,018	$1,149,359	2,900	917
2068	Year 41		$2,600,000	$0	$2,600,000	$802,836	2,900	895
2069	Year 42		$2,600,000	$0	$2,600,000	$783,811	2,900	874
2070	Year 43		$2,600,000	$0	$2,600,000	$765,238	2,900	854
2071	Year 44		$2,600,000	$0	$2,600,000	$747,104	2,900	833
2072	Year 45		$2,600,000	$0	$2,600,000	$729,400	2,900	814
2073	Year 46		$2,600,000	$0	$2,600,000	$712,116	2,900	794
2074	Year 47		$2,600,000	$0	$2,600,000	$695,241	2,900	775
2075	Year 48		$2,600,000	$0	$2,600,000	$678,766	2,900	757
2076	Year 49		$2,600,000	$0	$2,600,000	$662,682	2,900	739
2077	Year 50		$2,600,000	$0	$2,600,000	$646,978	2,900	722
2078	Year 51		$2,600,000	$0	$2,600,000	$631,647	2,900	705
2079	Year 52		$2,600,000	$0	$2,600,000	$616,679	2,900	688
2080	Year 53		$2,600,000	$0	$2,600,000	$602,066	2,900	672
2081	Year 54		$2,600,000	$0	$2,600,000	$587,799	2,900	656
2082	Year 55		$2,600,000	$0	$2,600,000	$573,870	2,900	640
2083	Year 56		$2,600,000	$0	$2,600,000	$560,271	2,900	625
2084	Year 57		$2,600,000	$0	$2,600,000	$546,995	2,900	610
2085	Year 58		$2,600,000	$0	$2,600,000	$534,033	2,900	596
2086	Year 59		$2,600,000	$0	$2,600,000	$521,378	2,900	582
2087	Year 60		$2,600,000	$1,034,365	$3,634,365	$711,529	2,900	568
2088	Year 61		$2,600,000	$513	$2,600,513	$497,059	2,900	554
2089	Year 62		$2,600,000	$755	$2,600,755	$485,325	2,900	541
2090	Year 63		$2,600,000	$1,098	$2,601,098	$473,887	2,900	528
2091	Year 64		$2,600,000	$1,582	$2,601,582	$462,744	2,900	516
2092	Year 65		$2,600,000	$2,256	$2,602,256	$451,895	2,900	504
2093	Year 66		$2,600,000	$3,186	$2,603,186	$441,345	2,900	492
2094	Year 67		$2,600,000	$4,453	$2,604,453	$431,096	2,900	480
2095	Year 68		$2,600,000	$6,163	$2,606,163	$421,157	2,900	469
2096	Year 69		$2,600,000	$8,445	$2,608,445	$411,537	2,900	458
2097	Year 70		$2,600,000	$11,457	$2,611,457	$402,249	2,900	447
2098	Year 71		$2,600,000	$15,388	$2,615,388	$393,308	2,900	436
2099	Year 72		$2,600,000	$20,462	$2,620,462	$384,733	2,900	426
2100	Year 73		$2,600,000	$26,939	$2,626,939	$376,544	2,900	416
2101	Year 74		$2,600,000	$35,112	$2,635,112	$368,765	2,900	406

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2102	Year 75		$2,600,000	$45,312	$2,645,312	$361,420	2,900	396
2103	Year 76		$2,600,000	$57,891	$2,657,891	$354,534	2,900	387
2104	Year 77		$2,600,000	$73,227	$2,673,227	$348,130	2,900	378
2105	Year 78		$2,600,000	$91,704	$2,691,704	$342,229	2,900	369
2106	Year 79		$2,600,000	$113,700	$2,713,700	$336,850	2,900	360
2107	Year 80		$2,600,000	$1,173,588	$3,773,588	$457,313	2,900	351
2108	Year 81		$2,600,000	$169,620	$2,769,620	$327,691	2,900	343
2109	Year 82		$2,600,000	$204,090	$2,804,090	$323,907	2,900	335
2110	Year 83		$2,600,000	$243,121	$2,843,121	$320,634	2,900	327
2111	Year 84		$2,600,000	$286,736	$2,886,736	$317,838	2,900	319
2112	Year 85		$2,600,000	$334,809	$2,934,809	$315,474	2,900	312
2113	Year 86		$2,600,000	$387,053	$2,987,053	$313,481	2,900	304
2114	Year 87		$2,600,000	$442,996	$3,042,996	$311,784	2,900	297
2115	Year 88		$2,600,000	$501,980	$3,101,980	$310,296	2,900	290
2116	Year 89		$2,600,000	$563,158	$3,163,158	$308,918	2,900	283
2117	Year 90		$2,600,000	$625,506	$3,225,506	$307,542	2,900	277
2118	Year 91		$2,600,000	$687,843	$3,287,843	$306,057	2,900	270
2119	Year 92		$2,600,000	$748,866	$3,348,866	$304,351	2,900	264
2120	Year 93		$2,600,000	$807,191	$3,407,191	$302,314	2,900	257
2121	Year 94		$2,600,000	$861,401	$3,461,401	$299,846	2,900	251
2122	Year 95		$2,600,000	$910,105	$3,510,105	$296,860	2,900	245
2123	Year 96		$2,600,000	$951,995	$3,551,995	$293,284	2,900	239
2124	Year 97		$2,600,000	$985,905	$3,585,905	$289,067	2,900	234
2125	Year 98		$2,600,000	$1,010,863	$3,610,863	$284,182	2,900	228
2126	Year 99		$2,600,000	$1,026,141	$3,626,141	$278,621	2,900	223
2127	Year 100		$2,600,000	$1,031,284	$3,631,284	$272,405	2,900	218

Table 78. Life-cycle cost for Morgan Hill Option 2 (GWR)

Morgan Hill - Option 2

Summary of Lifecycle Unit Costs ($/AF)				
Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 5,400	$ 4,800	$ 700	$ 6,100
30-Yr Lifecycle:	$ 6,100	$ 5,600	$ 1,100	$ 7,200

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	$75,000,000	$680,000,000	$170,000,000	$925,000,000	$315,000,000	190,000	59,000
	30-Yr Lifecycle:	$75,000,000	$205,000,000	$35,000,000	$315,000,000	$200,000,000	57,000	33,000
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$18,750,000		$0	$18,750,000	$16,631,258		
2025		$18,750,000		$0	$18,750,000	$16,237,152		
2026		$18,750,000		$0	$18,750,000	$15,852,386		
2027		$18,750,000		$0	$18,750,000	$15,476,737		
2028	Year 1		$6,800,000	$0	$6,800,000	$5,479,889	1,900	1,531
2029	Year 2		$6,800,000	$0	$6,800,000	$5,350,034	1,900	1,495
2030	Year 3		$6,800,000	$0	$6,800,000	$5,223,256	1,900	1,459
2031	Year 4		$6,800,000	$0	$6,800,000	$5,099,482	1,900	1,425
2032	Year 5		$6,800,000	$0	$6,800,000	$4,978,642	1,900	1,391
2033	Year 6		$6,800,000	$0	$6,800,000	$4,860,664	1,900	1,358
2034	Year 7		$6,800,000	$0	$6,800,000	$4,745,483	1,900	1,326
2035	Year 8		$6,800,000	$26,436	$6,826,436	$4,651,042	1,900	1,295
2036	Year 9		$6,800,000	$0	$6,800,000	$4,523,243	1,900	1,264
2037	Year 10		$6,800,000	$1,393,888	$8,193,888	$5,321,276	1,900	1,234
2038	Year 11		$6,800,000	$0	$6,800,000	$4,311,411	1,900	1,205
2039	Year 12		$6,800,000	$0	$6,800,000	$4,209,245	1,900	1,176
2040	Year 13		$6,800,000	$0	$6,800,000	$4,109,500	1,900	1,148
2041	Year 14		$6,800,000	$0	$6,800,000	$4,012,118	1,900	1,121
2042	Year 15		$6,800,000	$55,521	$6,855,521	$3,949,027	1,900	1,094
2043	Year 16		$6,800,000	$26,436	$6,826,436	$3,839,091	1,900	1,069
2044	Year 17		$6,800,000	$0	$6,800,000	$3,733,602	1,900	1,043
2045	Year 18		$6,800,000	$0	$6,800,000	$3,645,128	1,900	1,018
2046	Year 19		$6,800,000	$0	$6,800,000	$3,558,751	1,900	994
2047	Year 20		$6,800,000	$4,608,005	$11,408,005	$5,828,853	1,900	971
2048	Year 21		$6,800,000	$0	$6,800,000	$3,392,088	1,900	948
2049	Year 22		$6,800,000	$0	$6,800,000	$3,311,707	1,900	925
2050	Year 23		$6,800,000	$0	$6,800,000	$3,233,230	1,900	903
2051	Year 24		$6,800,000	$26,436	$6,826,436	$3,168,885	1,900	882

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2052	Year 25		$6,800,000	$26,363,208	$33,163,208	$15,029,820	1,900	861
2053	Year 26		$6,800,000	$0	$6,800,000	$3,008,783	1,900	841
2054	Year 27		$6,800,000	$0	$6,800,000	$2,937,485	1,900	821
2055	Year 28		$6,800,000	$0	$6,800,000	$2,867,877	1,900	801
2056	Year 29		$6,800,000	$0	$6,800,000	$2,799,917	1,900	782
2057	Year 30		$6,800,000	$2,003,347	$8,803,347	$3,538,905	1,900	764
2058	Year 31		$6,800,000	$0	$6,800,000	$2,668,792	1,900	746
2059	Year 32		$6,800,000	$917	$6,800,917	$2,605,902	1,900	728
2060	Year 33		$6,800,000	$25,519	$6,825,519	$2,553,354	1,900	711
2061	Year 34		$6,800,000	$0	$6,800,000	$2,483,528	1,900	694
2062	Year 35		$6,800,000	$0	$6,800,000	$2,424,677	1,900	677
2063	Year 36		$6,800,000	$0	$6,800,000	$2,367,220	1,900	661
2064	Year 37		$6,800,000	$0	$6,800,000	$2,311,124	1,900	646
2065	Year 38		$6,800,000	$0	$6,800,000	$2,256,359	1,900	630
2066	Year 39		$6,800,000	$0	$6,800,000	$2,202,890	1,900	616
2067	Year 40		$6,800,000	$5,469,347	$12,269,347	$3,880,522	1,900	601
2068	Year 41		$6,800,000	$25,519	$6,825,519	$2,107,605	1,900	587
2069	Year 42		$6,800,000	$0	$6,800,000	$2,049,968	1,900	573
2070	Year 43		$6,800,000	$0	$6,800,000	$2,001,391	1,900	559
2071	Year 44		$6,800,000	$0	$6,800,000	$1,953,965	1,900	546
2072	Year 45		$6,800,000	$55,521	$6,855,521	$1,923,238	1,900	533
2073	Year 46		$6,800,000	$0	$6,800,000	$1,862,457	1,900	520
2074	Year 47		$6,800,000	$0	$6,800,000	$1,818,323	1,900	508
2075	Year 48		$6,800,000	$917	$6,800,917	$1,775,474	1,900	496
2076	Year 49		$6,800,000	$25,519	$6,825,519	$1,739,672	1,900	484
2077	Year 50		$6,800,000	$33,184,610	$39,984,610	$9,949,683	1,900	473
2078	Year 51		$6,800,000	$0	$6,800,000	$1,652,000	1,900	462
2079	Year 52		$6,800,000	$0	$6,800,000	$1,612,853	1,900	451
2080	Year 53		$6,800,000	$0	$6,800,000	$1,574,634	1,900	440
2081	Year 54		$6,800,000	$0	$6,800,000	$1,537,320	1,900	430
2082	Year 55		$6,800,000	$0	$6,800,000	$1,500,891	1,900	419
2083	Year 56		$6,800,000	$917	$6,800,917	$1,465,522	1,900	409
2084	Year 57		$6,800,000	$0	$6,800,000	$1,430,601	1,900	400
2085	Year 58		$6,800,000	$25,519	$6,825,519	$1,401,942	1,900	390
2086	Year 59		$6,800,000	$0	$6,800,000	$1,363,604	1,900	381
2087	Year 60		$6,800,000	$5,171,890	$11,971,890	$2,343,833	1,900	372
2088	Year 61		$6,800,000	$398	$6,800,398	$1,299,820	1,900	363
2089	Year 62		$6,800,000	$587	$6,800,587	$1,269,054	1,900	355
2090	Year 63		$6,800,000	$853	$6,800,853	$1,239,030	1,900	346
2091	Year 64		$6,800,000	$2,146	$6,802,146	$1,209,899	1,900	338
2092	Year 65		$6,800,000	$1,754	$6,801,754	$1,181,160	1,900	330
2093	Year 66		$6,800,000	$27,994	$6,827,994	$1,157,619	1,900	322
2094	Year 67		$6,800,000	$3,461	$6,803,461	$1,126,127	1,900	314
2095	Year 68		$6,800,000	$4,789	$6,804,789	$1,099,656	1,900	307
2096	Year 69		$6,800,000	$6,563	$6,806,563	$1,073,878	1,900	300
2097	Year 70		$6,800,000	$1,448,635	$8,248,635	$1,270,556	1,900	293
2098	Year 71		$6,800,000	$11,958	$6,811,958	$1,024,397	1,900	286
2099	Year 72		$6,800,000	$16,819	$6,816,819	$1,000,836	1,900	279
2100	Year 73		$6,800,000	$20,934	$6,820,934	$977,709	1,900	272
2101	Year 74		$6,800,000	$52,806	$6,852,806	$959,001	1,900	266

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2102	Year 75		$6,800,000	$32,198,094	$38,998,094	$5,328,180	1,900	260
2103	Year 76		$6,800,000	$44,989	$6,844,989	$913,047	1,900	253
2104	Year 77		$6,800,000	$56,907	$6,856,907	$892,963	1,900	247
2105	Year 78		$6,800,000	$71,267	$6,871,267	$873,628	1,900	242
2106	Year 79		$6,800,000	$88,361	$6,888,361	$855,048	1,900	236
2107	Year 80		$6,800,000	$5,531,970	$12,331,970	$1,494,486	1,900	230
2108	Year 81		$6,800,000	$131,819	$6,931,819	$820,146	1,900	225
2109	Year 82		$6,800,000	$158,607	$6,958,607	$803,806	1,900	219
2110	Year 83		$6,800,000	$214,459	$7,014,459	$791,057	1,900	214
2111	Year 84		$6,800,000	$222,835	$7,022,835	$773,234	1,900	209
2112	Year 85		$6,800,000	$260,195	$7,060,195	$758,927	1,900	204
2113	Year 86		$6,800,000	$300,795	$7,100,795	$745,204	1,900	199
2114	Year 87		$6,800,000	$344,271	$7,144,271	$731,999	1,900	195
2115	Year 88		$6,800,000	$391,027	$7,191,027	$719,330	1,900	190
2116	Year 89		$6,800,000	$437,654	$7,237,654	$706,838	1,900	186
2117	Year 90		$6,800,000	$2,363,896	$9,163,896	$873,750	1,900	181
2118	Year 91		$6,800,000	$560,071	$7,360,071	$685,131	1,900	177
2119	Year 92		$6,800,000	$581,976	$7,381,976	$670,887	1,900	173
2120	Year 93		$6,800,000	$627,302	$7,427,302	$659,011	1,900	169
2121	Year 94		$6,800,000	$669,432	$7,469,432	$647,044	1,900	165
2122	Year 95		$6,800,000	$707,282	$7,507,282	$634,912	1,900	161
2123	Year 96		$6,800,000	$740,754	$7,540,754	$622,630	1,900	157
2124	Year 97		$6,800,000	$766,189	$7,566,189	$609,927	1,900	153
2125	Year 98		$6,800,000	$785,586	$7,585,586	$597,000	1,900	150
2126	Year 99		$6,800,000	$822,976	$7,622,976	$585,726	1,900	146
2127	Year 100		$6,800,000	$40,408,952	$47,208,952	$3,541,433	1,900	143

Table 79. Life-cycle cost for Morgan Hill Option 3 (SWA)

Morgan Hill - Option 3

Summary of Lifecycle Unit Costs ($/AF)

Time Horizon	Unit Costs, excluding ROC management	Unit Costs, excluding R&R and ROC management	ROCM Unit Costs Only	Unit Costs, including ROC management
100-Yr Lifecycle:	$ 5,900	$ 5,200	$ 700	$ 6,600
30-Yr Lifecycle:	$ 6,900	$ 6,400	$ 1,100	$ 8,000

[1] ROC management costs included for context only. Estimated ROC management lifecycle costs are based on Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
	100-Yr Lifecycle:	$95,000,000	$710,000,000	$190,000,000	$995,000,000	$345,000,000	190,000	59,000
	30-Yr Lifecycle:	$95,000,000	$215,000,000	$40,000,000	$345,000,000	$225,000,000	57,000	33,000
2019				$0	$0	$0		
2020				$0	$0	$0		
2021				$0	$0	$0		
2022				$0	$0	$0		
2023				$0	$0	$0		
2024		$23,750,000		$0	$23,750,000	$21,066,260		
2025		$23,750,000		$0	$23,750,000	$20,567,059		
2026		$23,750,000		$0	$23,750,000	$20,079,688		
2027		$23,750,000		$0	$23,750,000	$19,603,866		
2028	Year 1		$7,100,000	$0	$7,100,000	$5,721,649	1,900	1,531
2029	Year 2		$7,100,000	$0	$7,100,000	$5,586,065	1,900	1,495
2030	Year 3		$7,100,000	$0	$7,100,000	$5,453,694	1,900	1,459
2031	Year 4		$7,100,000	$0	$7,100,000	$5,324,460	1,900	1,425
2032	Year 5		$7,100,000	$0	$7,100,000	$5,198,287	1,900	1,391
2033	Year 6		$7,100,000	$0	$7,100,000	$5,075,105	1,900	1,358
2034	Year 7		$7,100,000	$0	$7,100,000	$4,954,842	1,900	1,326
2035	Year 8		$7,100,000	$26,436	$7,126,436	$4,855,440	1,900	1,295
2036	Year 9		$7,100,000	$0	$7,100,000	$4,722,798	1,900	1,264
2037	Year 10		$7,100,000	$1,584,901	$8,684,901	$5,640,150	1,900	1,234
2038	Year 11		$7,100,000	$0	$7,100,000	$4,501,621	1,900	1,205
2039	Year 12		$7,100,000	$0	$7,100,000	$4,394,947	1,900	1,176
2040	Year 13		$7,100,000	$0	$7,100,000	$4,290,801	1,900	1,148
2041	Year 14		$7,100,000	$0	$7,100,000	$4,189,124	1,900	1,121
2042	Year 15		$7,100,000	$55,521	$7,155,521	$4,121,837	1,900	1,094
2043	Year 16		$7,100,000	$26,436	$7,126,436	$4,007,807	1,900	1,069
2044	Year 17		$7,100,000	$0	$7,100,000	$3,898,320	1,900	1,043
2045	Year 18		$7,100,000	$0	$7,100,000	$3,805,943	1,900	1,018
2046	Year 19		$7,100,000	$0	$7,100,000	$3,715,754	1,900	994
2047	Year 20		$7,100,000	$5,312,461	$12,412,461	$6,342,074	1,900	971
2048	Year 21		$7,100,000	$0	$7,100,000	$3,541,739	1,900	948
2049	Year 22		$7,100,000	$0	$7,100,000	$3,457,811	1,900	925
2050	Year 23		$7,100,000	$0	$7,100,000	$3,375,873	1,900	903
2051	Year 24		$7,100,000	$26,436	$7,126,436	$3,308,148	1,900	882

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2052	Year 25		$7,100,000	$27,399,774	$34,499,774	$15,635,562	1,900	861
2053	Year 26		$7,100,000	$0	$7,100,000	$3,141,524	1,900	841
2054	Year 27		$7,100,000	$0	$7,100,000	$3,067,080	1,900	821
2055	Year 28		$7,100,000	$0	$7,100,000	$2,994,401	1,900	801
2056	Year 29		$7,100,000	$0	$7,100,000	$2,923,443	1,900	782
2057	Year 30		$7,100,000	$2,226,196	$9,326,196	$3,749,088	1,900	764
2058	Year 31		$7,100,000	$0	$7,100,000	$2,786,533	1,900	746
2059	Year 32		$7,100,000	$917	$7,100,917	$2,720,853	1,900	728
2060	Year 33		$7,100,000	$25,519	$7,125,519	$2,665,581	1,900	711
2061	Year 34		$7,100,000	$0	$7,100,000	$2,593,095	1,900	694
2062	Year 35		$7,100,000	$0	$7,100,000	$2,531,648	1,900	677
2063	Year 36		$7,100,000	$0	$7,100,000	$2,471,656	1,900	661
2064	Year 37		$7,100,000	$0	$7,100,000	$2,413,086	1,900	646
2065	Year 38		$7,100,000	$0	$7,100,000	$2,355,904	1,900	630
2066	Year 39		$7,100,000	$0	$7,100,000	$2,300,077	1,900	616
2067	Year 40		$7,100,000	$6,173,803	$13,273,803	$4,198,209	1,900	601
2068	Year 41		$7,100,000	$25,519	$7,125,519	$2,200,240	1,900	587
2069	Year 42		$7,100,000	$0	$7,100,000	$2,140,408	1,900	573
2070	Year 43		$7,100,000	$0	$7,100,000	$2,089,688	1,900	559
2071	Year 44		$7,100,000	$0	$7,100,000	$2,040,169	1,900	546
2072	Year 45		$7,100,000	$55,521	$7,155,521	$2,007,399	1,900	533
2073	Year 46		$7,100,000	$0	$7,100,000	$1,944,624	1,900	520
2074	Year 47		$7,100,000	$0	$7,100,000	$1,898,543	1,900	508
2075	Year 48		$7,100,000	$917	$7,100,917	$1,853,793	1,900	496
2076	Year 49		$7,100,000	$25,519	$7,125,519	$1,816,135	1,900	484
2077	Year 50		$7,100,000	$34,674,514	$41,774,514	$10,395,079	1,900	473
2078	Year 51		$7,100,000	$0	$7,100,000	$1,724,882	1,900	462
2079	Year 52		$7,100,000	$0	$7,100,000	$1,684,008	1,900	451
2080	Year 53		$7,100,000	$0	$7,100,000	$1,644,103	1,900	440
2081	Year 54		$7,100,000	$0	$7,100,000	$1,605,143	1,900	430
2082	Year 55		$7,100,000	$0	$7,100,000	$1,567,107	1,900	419
2083	Year 56		$7,100,000	$917	$7,100,917	$1,530,169	1,900	409
2084	Year 57		$7,100,000	$0	$7,100,000	$1,493,716	1,900	400
2085	Year 58		$7,100,000	$25,519	$7,125,519	$1,463,562	1,900	390
2086	Year 59		$7,100,000	$0	$7,100,000	$1,423,763	1,900	381
2087	Year 60		$7,100,000	$5,877,784	$12,977,784	$2,540,765	1,900	372
2088	Year 61		$7,100,000	$642	$7,100,642	$1,357,208	1,900	363
2089	Year 62		$7,100,000	$943	$7,100,943	$1,325,103	1,900	355
2090	Year 63		$7,100,000	$1,371	$7,101,371	$1,293,780	1,900	346
2091	Year 64		$7,100,000	$2,894	$7,102,894	$1,263,393	1,900	338
2092	Year 65		$7,100,000	$2,819	$7,102,819	$1,233,442	1,900	330
2093	Year 66		$7,100,000	$29,499	$7,129,499	$1,208,736	1,900	322
2094	Year 67		$7,100,000	$5,564	$7,105,564	$1,176,132	1,900	314
2095	Year 68		$7,100,000	$7,701	$7,107,701	$1,148,607	1,900	307
2096	Year 69		$7,100,000	$10,553	$7,110,553	$1,121,838	1,900	300
2097	Year 70		$7,100,000	$1,675,622	$8,775,622	$1,351,729	1,900	293
2098	Year 71		$7,100,000	$19,227	$7,119,227	$1,070,605	1,900	286
2099	Year 72		$7,100,000	$26,485	$7,126,485	$1,046,301	1,900	279
2100	Year 73		$7,100,000	$33,662	$7,133,662	$1,022,536	1,900	272
2101	Year 74		$7,100,000	$69,394	$7,169,394	$1,003,305	1,900	266

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Water Supply System Yield (AF)	Present Value Yield (AF) in 2019
		Capital Cost	O&M Cost	R&R	Total Cost			
2102	Year 75		$7,100,000	$33,383,408	$40,483,408	$5,531,113	1,900	260
2103	Year 76		$7,100,000	$72,337	$7,172,337	$956,711	1,900	253
2104	Year 77		$7,100,000	$91,501	$7,191,501	$936,536	1,900	247
2105	Year 78		$7,100,000	$114,589	$7,214,589	$917,279	1,900	242
2106	Year 79		$7,100,000	$142,074	$7,242,074	$898,954	1,900	236
2107	Year 80		$7,100,000	$6,271,799	$13,371,799	$1,620,500	1,900	230
2108	Year 81		$7,100,000	$211,950	$7,311,950	$865,122	1,900	225
2109	Year 82		$7,100,000	$255,021	$7,355,021	$849,597	1,900	219
2110	Year 83		$7,100,000	$329,314	$7,429,314	$837,842	1,900	214
2111	Year 84		$7,100,000	$358,292	$7,458,292	$821,179	1,900	209
2112	Year 85		$7,100,000	$418,363	$7,518,363	$808,177	1,900	204
2113	Year 86		$7,100,000	$483,645	$7,583,645	$795,877	1,900	199
2114	Year 87		$7,100,000	$553,548	$7,653,548	$784,180	1,900	195
2115	Year 88		$7,100,000	$628,170	$7,728,170	$773,062	1,900	190
2116	Year 89		$7,100,000	$703,698	$7,803,698	$762,119	1,900	186
2117	Year 90		$7,100,000	$2,880,968	$9,980,968	$951,655	1,900	181
2118	Year 91		$7,100,000	$885,017	$7,985,017	$743,306	1,900	177
2119	Year 92		$7,100,000	$935,751	$8,035,751	$730,303	1,900	173
2120	Year 93		$7,100,000	$1,008,630	$8,108,630	$719,463	1,900	169
2121	Year 94		$7,100,000	$1,076,369	$8,176,369	$708,283	1,900	165
2122	Year 95		$7,100,000	$1,137,228	$8,237,228	$696,646	1,900	161
2123	Year 96		$7,100,000	$1,190,490	$8,290,490	$684,535	1,900	157
2124	Year 97		$7,100,000	$1,231,945	$8,331,945	$671,656	1,900	153
2125	Year 98		$7,100,000	$1,263,132	$8,363,132	$658,194	1,900	150
2126	Year 99		$7,100,000	$1,307,740	$8,407,740	$646,025	1,900	146
2127	Year 100		$7,100,000	$42,691,669	$49,791,669	$3,735,178	1,900	143

Appendix A-7: Evaluation and Risk Assessment Tool

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Table of Contents

Section 1: Evaluation Tool....1
1.1 Approach and Methodology....1
1.2 Portfolio Comparison....11
1.2.1 Economics....11
1.2.2 Countywide (Regional) Supply Reliability....11
1.2.3 Environmental Impacts/Benefits and Sustainability....11
1.2.4 Ease of Implementation and Permitting/Regulatory Considerations....12
1.2.5 Engineering Feasibility....13
1.3 South County Reuse Options Evaluation....14
1.3.1 Economics....15
1.3.2 Groundwater Management and Countywide (Regional) Supply Reliability....15
1.3.3 Environmental Impacts/Benefits and Sustainability....15
1.3.4 Ease of Implementation and Permitting/Regulatory Considerations....16
1.3.5 Engineering Feasibility....16
Section 2: Risk Assessment....16
2.1 Risk Identification....17
2.2 Risk Analysis....18
2.3 Risk Mitigation....22
Section 3: Key Findings and Next Steps....23

List of Figures

Figure 1-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward economics 10

Figure 2-1. Example Risk Matrix comparison of portfolios and options indicating the likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis 18

List of Tables

Table 1-1. Evaluation Criteria and Previously Established Weighting....1

Table 1-2. Portfolio Prioritization Criteria Definition and Score Ranges 5

Table 1-3. Public Health Regulatory Compliance Evaluation ....**Error! Bookmark not defined.**

Table 1-4. Environmental Discharge Regulatory Compliance Evaluation**Error! Bookmark not defined.**

Table 1-5. Evaluation Matrix of Raw Scores 7

Table 1-6. Evaluation Matrix of Converted Scores 8

Table 1-7. Evaluation Criteria, Sub-Criteria, and Weighting Factors 9

Table 1-8. South County NPR Element Qualitative Comparison 14

Table 1-9. South County PR Element Qualitative Comparison....15

Table 2-1. Risk Score Key[a]....19

Table 2-2. Risk Matrix: Relative Comparison of Risks for North County Portfolios and South County Options....20

Appendix A-7:

Evaluation and Risk Assessment Tool

This appendix describes the approach, methods, and key findings related to evaluating reuse portfolios and assessing risks.

Section 1: Evaluation Tool

The evaluation tool is used to compare portfolios relative to one another with respect to prioritization criteria identified by Valley Water and Partner Agency staff, who collectively form the Countywide Water Reuse Master Plan (CoRe Plan) Project Partner Group (PPG). The five evaluation criteria reflect program goals and input from the PPG and are further defined by 19 sub-criteria. Several program goals that are important to PPG members are not reflected in the latest version of the criteria and sub-criteria because the evaluation tool focuses on sub-criteria that distinguish between portfolios and set them apart from one another. All portfolios protect groundwater and surface water quality, as required by Valley Water.

As conditions change and new information becomes available, it is anticipated that portfolios will perform differently with respect to the criteria and sub-criteria, and results of the tool will change.

1.1 Approach and Methodology

In October 2018, Valley Water hosted a meeting with its Partner Agencies, and the PPG reached collective agreement on five evaluation criteria representing broad categories with descriptions further defining attributes of each. At that early stage in the project, the criteria served an anticipated purpose of prioritizing alternatives with the objective of recommending one alternative to proceed to implementation. As such, the PPG also conferred and agreed on weighting factors pertaining to the five criteria (Table 1-1).

Table 1-1. Evaluation Criteria and Previously Established Weighting

Criterion	Notes	Weighting
Economics	Including 30-year life-cycle costs and unit costs that may directly impact customer affordability.	25%
Supply reliability	Including yield (projected production of reuse water) and utilization (amount of water the delivery point can hold/use).	25%
Environmental and social impacts/benefits	Including energy use, environmental/social justice, local reuse benefit (i.e., product water stays in service area), and water rights equity.	20%
Ease of implementation and permitting/regulatory considerations	Including partnerships/agreements, public health regulatory compliance, environmental discharge compliance, design readiness, NEPA/CEQA and permit requirements, and public acceptance/support.	15%
Engineering feasibility	Including the need for a pilot study, ease of pipeline construction, land acquisition/ownership, site preparation requirements, and ease of operation.	15%
	Total	100%

As the project progressed, Valley Water opted to shift the approach from selecting one recommended alternative to evaluating multiple portfolios to allow flexibility in implementation. Given this shift, the Project Team established an approach and methodology to evaluate project portfolios/options in a manner that readily allows sensitivity testing to determine how portfolios and options compare with variable weighting factor scenarios. In addition, the approach aims to avoid arbitrary and subjective scoring by taking the following steps.

1. **Sort quantitative and qualitative sub-criteria and define respective scoring scales.** The identified sub-criteria (Table 1-2) are applied differently based on whether they are quantitative or qualitative:
   - Quantitative sub-criteria are numerical/design characteristics (e.g., estimated costs, energy use, or purified water production) and scored using actual values.
   - Qualitative characteristics are not as easy to measure. Each portfolio/option is evaluated relative to others using an increasing positive scale ranging from 1 to 2 (e.g., a binary option where 1= no benefit; and 2 = benefit) to 1 to 4 (i.e., where 1 = less benefit and/or greater risk; and 4 = more benefit and/or lower risk).
   - Regulatory criteria are qualitative and based on the comparison of Portfolios' regulatory strategy described in Appendix B-1 and presented in Tables 1-3 and 1-4.
2. **Score each portfolio/option based on each sub-criterion using Table 1-2 score definitions.** Developing scores begins by populating "raw scores" (i.e., actual value for quantitative sub-criteria or rating based on the respective qualitative sub-criteria scale), as shown in Table 1-5.
3. **Convert Scores to a normalized range of 0 to 1.** To compare scores in a single framework, normalize the raw scores on a 0 to 1 scale. Conversion varies by type of sub-criterion:
   - For quantitative sub-criteria where higher values provide more benefit (e.g., yield): Divide each raw score by the maximum possible raw score.

     score ÷ highest score = 0 to 1 normalized score (a percentage)
   - For quantitative sub-criteria where lower values provide more benefit (e.g., cost or energy use): Multiply each raw score by the inverse of the lowest possible raw score.

     score × (1÷lowest score) = 0 to 1 normalized score (a percentage)
   - For qualitative sub-criteria: Use the highest possible rating based on the defined sub-criterion range as the denominator. Divide each score/rating by the denominator.

   score ÷ highest score = 0 to 1 normalized score (a percentile)

   Converted scores are presented in Table 1-6.
4. **Calculate criteria and total portfolio/option scores.** Within each criterion, sum sub-criteria scores to arrive at a criterion score. After applying the respective weighting factor to each criterion, criteria scores can be summed to determine the total score for a portfolio/option.

In converting quantitative and qualitative criteria to a normalized and comparable scale, this approach avoids the risk of two forms of mathematical skewing that can occur with scorecard comparison tools. If quantifiable values are converted to simpler scales or bins, the relative difference between them can be lost. Likewise, if qualitative factors are converted into numeric scales (e.g., 1, 2, 3, 4, symbolizing poor, fair, good, best), the appearance both visually and mathematically is that a score of 4 is twice as good as a score of 2, though the intent is simply to establish that the alternative with a 4 is better than that with a 2. Because it is a subjective factor, the extent of relative benefit is uncertain. The approach used in this evaluation avoids both types of skew by converting numeric values to comparative percentages and qualitative scales into percentiles, which indicate how many alternatives are less preferred.

During score "conversion" to a 0 to 1 scale, raw scores for quantitative sub-criteria that are on a positive scale—where larger values provide more benefit, such as potable reuse (PR) water yield—were divided by the maximum score (the largest value assigned to a portfolio within that sub-criterion). Quantitative sub-criteria such as cost or energy use where lower values provide more benefit were converted by dividing the minimum portfolio raw score by the raw score for the portfolio being evaluated. Qualitative sub-criteria percentiles indicate how many other portfolios over which that portfolio is preferred. If one portfolio is preferred over four other portfolios for a sub-criterion, it would receive a score of 1 ([4 portfolios of relative lower preference]/[4 total other portfolios]). A portfolio that is not preferred over any others would receive a score of zero. Using this method, it does not matter that the qualitative criteria had variable scales (0 to 2 vs. 0 to 4), as all scores are normalized to 0, 0.25, 0.5, 0.75, or 1. Converted scores are shown in Table 1-6.

Evaluation criteria can be evenly weighted (such that each equally contributes to the overall portfolio score) or assigned individual weights to reflect relative importance of each, so long as the sum of criteria weights equals 1 (i.e., 100%). To test the impact of adjusting weighting values on portfolio scores and relative rankings, four variations were considered and applied to converted scores (Table 1-7). Sub-criteria weights represent criteria weights divided by the number of sub-criteria.

Figure 1-1 illustrates how portfolio scores vary when criteria and sub-criteria weights are altered. Figure 1-1(a) presents criteria weighting taken from the October 2018 PPG meeting. Figure 1-1(b) presents equal criteria weighting: all criteria receive a 20 percent weight, and individual sub-criteria are less important. Figure 1-1(c) presents a scenario with equally weighted sub-criteria; each sub-criteria receives a 5.2 percent weight, and criteria that have the most sub-criteria are therefore weighted most heavily and influence overall portfolio scores the most. As an experiment, Figure 1-1(d) is included to heavily weight one criterion—cost—and no other criteria.

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Table 1-2. Portfolio Prioritization Criteria Definition and Score Ranges

Criteria	Sub-criteria	Quantitative (with units) or Qualitative	Most favorable raw score (lowest/highest)	Score range/scale			
				1 (less benefit)	2	3	4 (more benefit)
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield, including reverse osmosis concentrate (ROC) Management	$/AF	2,500 (lowest)				
	Estimated 30-year life-cycle costs (capital, O&M, R&R) excluding ROC Management - present value in millions	$, millions	955 (lowest)				
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower-bound flow projection	AFY	24,000 (highest)				
	Purified water usage (limited by delivery point)	AFY	24,000 (highest)				
3. Environmental and social impacts/benefits	Minimizing carbon footprint (energy use as a surrogate)	MWh/yr	67,100 (lowest)				
	Environmental and social justice	Qualitative	2 (highest)	• Inequitable allocation of resources and benefits; lower income areas receive disproportionate impacts	• Equitable allocation of resources and benefits; well-mitigated and distributed impacts (e.g., equally affecting varying income and minority areas)		
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	Qualitative	3 (highest)	• Retains <50% of product water in wastewater agency service area (rate payers may not benefit)	• Retains >50% of product water in wastewater agency service area	• Fully retains product water within wastewater agency service area (rate payers will benefit)	
	Equity in supply benefits (with respect to water rights)	Qualitative	3 (highest)	• Portfolio diverts supply away from an area with fewer or less secure water rights	• Neutral (i.e., no measurable local supply benefits or impacts to water security)	• Portfolio yields supply benefit to an area/retailer with less secure water rights	
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	Qualitative	3 (highest)	• Agencies communicating but agreement not being discussed	• Approval in process	• Agreements and/or governance structure established	
	Ease of public health regulatory compliance – see Table 1-3 for results.	Qualitative	4 (highest)	• Low ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and technical, managerial, and financial (TMF) capacity • Scoring resulted in more than 4 medium or dark blue boxes, with more than 1 dark blue box (see Table 1-3).	• Medium-low ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in more than 4 medium or dark blue boxes, with 1 dark blue box (see Table 1-3)	• Medium-high ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in 3 or 4 medium or dark blue boxes, with 0 or 1 dark blue box (see Table 1-3)	• High ranking with regard to public health criteria: pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. • Scoring resulted in 2 or fewer medium blue boxes and no dark blue boxes (see Table 1-3)
	Ease of environmental discharge regulatory compliance – see Table 1-4 for results.	Qualitative	3 (highest)	• 1 or more medium or dark blue box (see Table 1-4).	• No medium or dark blue boxes (see Table 1-4)	• No environmental discharges	
	Design readiness	Qualitative	3 (highest)	• Conceptual studies and designs not yet started	• Conceptual studies and designs in progress	• Conceptual studies and designs prepared	
	Anticipated permit requirements	Qualitative	3 (highest)	• Section 401/404 permit required; Section 7 consultation effort substantial; Section 106 consultation effort substantial; and more than 6 likely endangered species that may require habitat mitigation prior to construction	• Section 401/404 permit required; Section 7 consultation effort moderate; Section 106 consultation effort moderate; and fewer than 6 likely endangered species that may require habitat mitigation prior to permitting	• Section 401/404 permit may not be required; Section 7 consultation effort minimal; Section 106 consultation not required; and fewer than 5 likely endangered species that may require habitat mitigation prior to permitting	
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	Qualitative	3 (highest)	• Known public unease with PR or known public unease with proposed use of site(s) for new facilities	• Public support neutral or unknown	• Known public support of elements of PR plans and/or proposed use of site(s) for new facilities	

Table 1-2. Portfolio Prioritization Criteria Definition and Score Ranges

Criteria	Sub-criteria	Quantitative (with units) or Qualitative	Most favorable raw score (lowest/highest)	Score range/scale			
				1 (less benefit)	2	3	4 (more benefit)
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	Qualitative	2 (highest)	• Pilot study needed	• No pilot study needed		
	Ease of pipeline construction	Qualitative	2 (highest)	• Proposed pipeline alignments have significant potential construction or engineering challenges, such as crowded corridors (i.e., existing utilities conflicts), higher traffic impacts, need for more trenchless construction, additional right of way.	• Proposed pipeline alignments do not have known challenges with other utilities, traffic, or engineering challenges.		
	Land acquisition/ownership	Qualitative	2 (highest)	• Land is not currently available for use. For example, voter approval is required for site use, or land is held privately and will need to be purchased.	• No known land acquisition issues other than price negotiation		
	Site preparation requirements	Qualitative	2 (highest)	• Significant site work required before site is ready for construction	• Minimal site work required		
	Ease of operation	Qualitative	3 (highest)	• Facility operation requires more technical expertise • Most (5+) unit processes to operate	• Facility operation requires moderate technical expertise • Moderate number (4) of unit processes to operate	• Facility operation is simple • Least number (3-) of unit processes to operate	

Table 1-3. Regulatory Complexity related to Public Health Considerations in the Potable Reuse Portfolios

Reuse type	GWR	SWA	RWA	TWA	
Portfolio / Option	1a: SJ GWR 2a: PA (+SV) GWR 2b: SV (+PA) GWR 4: PA/SV GWR MH-2: GWR	MH-3: SWA	1b: SJ RWA	1c: SJ TWA, Milpitas Pipeline	1d: SJ TWA, new pipeline
Pathogen removal	○	○	○	○	
Chemical removal	○	○	○	◒	
Source control	○	○	◒	◒	
Monitoring and control	○	○	◒	●	◒
Retention and response time	○	○	◒	◒	
TMF capacity	◒	◒	●	●	

○ *low complexity* ◒ *medium complexity* ● *high complexity*

Table 1-4. Regulatory Complexity related to Discharge of Purified Water to the Environment in the Potable Reuse Portfolios

Reuse type	GWR	SWA	RWA/TWA
Portfolio / Option	1a: SJ GWR 2a: PA (+SV) GWR 2b: SV (+PA) GWR 4: PA/SV GWR MH-2: GWR	MH-3: SWA	1b: SJ RWA 1c: SJ TWA, Milpitas Pipeline 1d: SJ TWA, new pipeline
SF Basin Plan	○	○	N/A
California Toxics Rule	○	◒	N/A
SNMP	○	N/A	N/A
Anti-degradation	○	○	N/A
Chlorine residual	○	○	N/A

○ *low complexity* ◒ *medium complexity* ● *high complexity* *N/A indicates options that do not involve discharges to the environment*

Table 1-5. Evaluation Matrix of Raw Scores

Criteria	Sub-criteria	Most favorable raw score (lowest/highest)	1a: SJ GWR	1b: SJ RWA	1c: SJ TWA (Milpitas Pipeline)	1d: SJ TWA (new pipeline)	2a: PA (+SV) GWR	2b: SV (+PA) GWR	4: PA/SV GWR
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield, including ROC Management	2,500 (lowest)	2,600	2,700	2,500	2,600	3,000	3,000	3,200
	Estimated 30-year life-cycle costs (capital, O&M, R&R), excluding ROC Management - present value in millions	955 (lowest)	975	1,045	955	1,000	1,110	1,095	1,170
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower-bound flow projection	24,000 (highest)	24,000	24,000	24,000	24,000	17,000	17,000	17,000
	Purified water usage (assumed delivery point capacity)	24,000 (highest)	19,000	19,800	24,000	24,000	19,000	19,000	19,000
3. Environmental impacts/benefits and sustainability	Minimizing carbon footprint (annual energy use as a surrogate) – in megawatt-hours (MWh) per year	67,100 (lowest)	67,100	80,300	76,900	76,900	74,400	71,600	75,700
	Environmental and social justice	2 (highest)	2	2	1	1	1	1	1
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	3 (highest)	2	3	3	3	1	1	1
	Equity in supply benefits (with respect to water rights)	3 (highest)	1	2	2	2	3	3	3
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	3 (highest)	1	1	1	1	3	2	2
	Ease of public health regulatory compliance	3 (highest)	4	3	1	2	4	4	4
	Ease of environmental discharge regulatory compliance	2 (highest)	1	2	2	2	1	1	1
	Design readiness	3 (highest)	3	2	1	1	1	1	1
	Anticipated permit requirements	3 (highest)	2	2	2	2	3	1	1
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	3 (highest)	3	2	1	1	3	2	2
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	2 (highest)	2	1	1	1	2	2	2
	Ease of pipeline construction	2 (highest)	2	1	1	1	1	1	1
	Land acquisition/ownership	2 (highest)	2	2	2	2	1	2	1
	Site preparation requirements	2 (highest)	2	2	2	2	2	1	1
	Ease of operation	3 (highest)	3	2	1	1	3	3	3

Table 1-6. Evaluation Matrix of Converted Scores

Criteria	Sub-criteria	1a: SJ GWR	1b: SJ RWA	1c: SJ TWA (Milpitas Pipeline)	1d: SJ TWA (new pipeline)	2a: PA (+SV) GWR	2b: SV (+PA) GWR	4: PA/SV GWR
1. Economics	Unit cost of annual yield ($/AF) – 30-year life-cycle AF using upper-bound yield	0.96	0.93	1.00	0.96	0.83	0.83	0.78
	Estimated 30-year life-cycle costs (capital, O&M, R&R) - present value in millions	0.98	0.91	1.00	0.96	0.86	0.87	0.82
2. Countywide (regional) supply reliability	Anticipated PR annual yield using lower bound flow projection	1.00	1.00	1.00	1.00	0.71	0.71	0.71
	Purified water usage (assumed delivery point capacity)	0.79	0.83	1.00	1.00	0.79	0.79	0.79
3. Environmental impacts/benefits and sustainability	Minimizing carbon footprint (energy use as a surrogate)	1.00	0.84	0.87	0.87	0.90	0.94	0.89
	Environmental and social justice	0.83	0.83	0.00	0.00	0.00	0.00	0.00
	Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area	0.50	0.67	0.67	0.67	0.00	0.00	0.00
	Equity in supply benefits (with respect to water rights)	0.00	0.17	0.17	0.17	0.67	0.67	0.67
4. Ease of implementation and regulatory compliance	Willing partner(s) interested in collaborating	0.00	0.00	0.00	0.00	1.00	0.67	0.67
	Ease of public health regulatory compliance	0.50	0.33	0.00	0.17	0.50	0.50	0.50
	Ease of environmental discharge regulatory compliance	0.00	0.67	0.67	0.67	0.00	0.00	0.00
	Design readiness	1.00	0.83	0.00	0.00	0.00	0.00	0.00
	Anticipated permit requirements	0.33	0.33	0.33	0.33	1.00	0.00	0.00
	Public acceptance/support (for potable reuse and use of site(s) for new facilities)	0.83	0.33	0.00	0.00	0.83	0.33	0.33
5. Engineering, construction, and operations	Need for pilot study (treatment technology proven at full scale)	0.50	0.00	0.00	0.00	0.50	0.50	0.50
	Ease of pipeline construction	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition/ownership	0.33	0.33	0.33	0.33	0.00	0.33	0.00
	Site preparation requirements	0.33	0.33	0.33	0.33	0.33	0.00	0.00
	Ease of operation	0.50	0.33	0.00	0.00	0.50	0.50	0.50

🟩 = *Dark green represents a normalized score of “1,” and represents the highest scoring portfolio(s).*

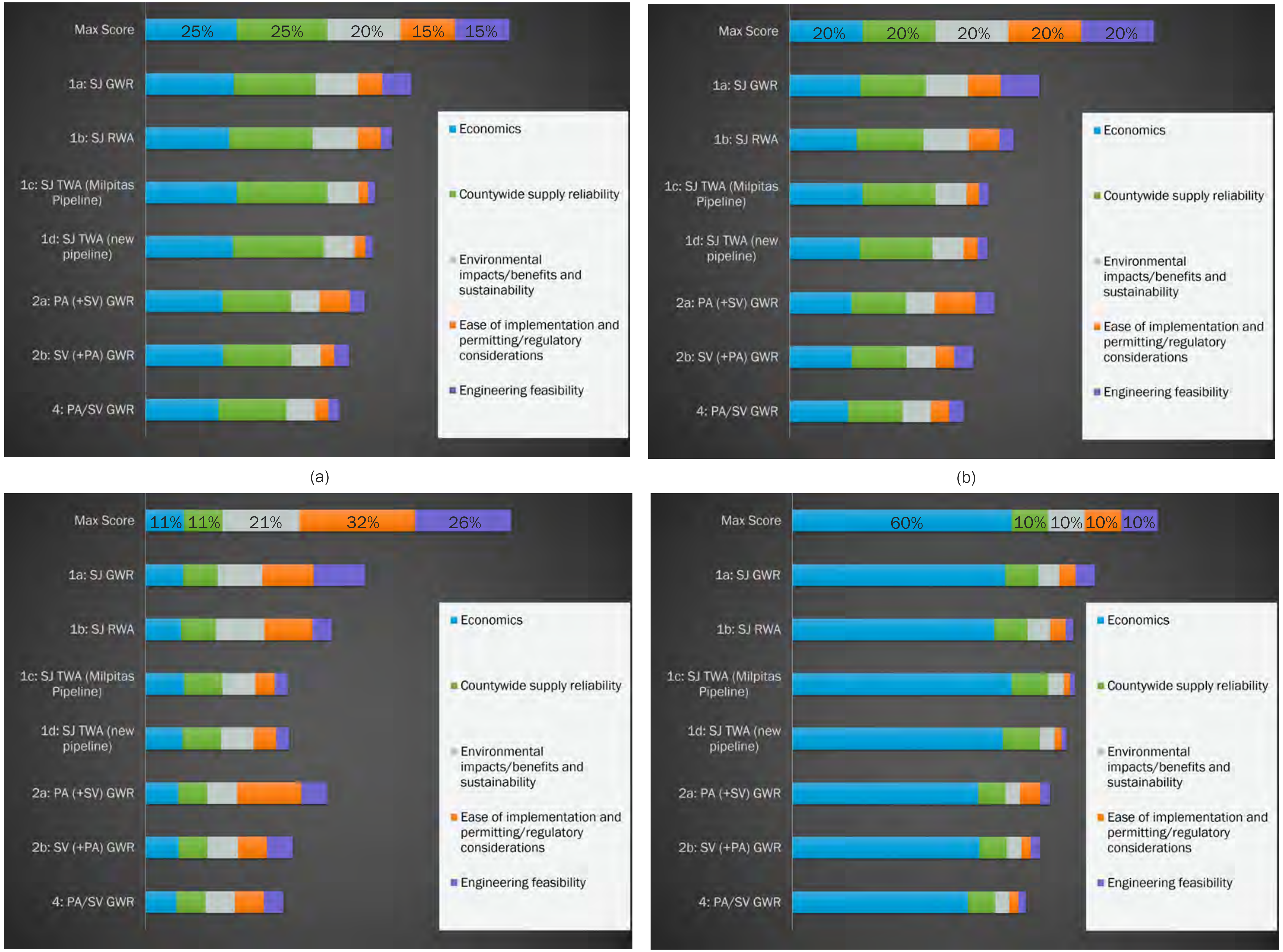
🟩 = *Represents a normalized score of 0.75*

🟩 = *Represents a normalized score of 0.5*

🟩 = *Represents a normalized score of 0.25*

Table 1-7. Evaluation Criteria, Sub-Criteria, and Weighting Factors

Criteria	Weight of Criteria				Sub-Criteria (used to further define and score criteria)	Weight of Individual Sub-Criteria			
	Scenario A: PPG Weights from Oct. 2018	Scenario B: Equal Criteria Weights	Scenario C: Equal Sub-Criteria Weights	Scenario D: Heavily Weighted Economics		Scenario A: PPG Weights from Oct. 2018	Scenario B: Equal Criteria Weights	Scenario C: Equal Sub-Criteria Weights	Scenario D: Heavily Weighted Economics
Economics	25%	20%	10.5%	60%	Unit cost of annual yield of PR supply: 30-year Estimated life-cycle costs: 30-year	12.5%	10%	5.3%	30%
Countywide (regional) supply reliability	25%	20%	10.5%	10%	Anticipated PR annual yield (lower bound) Purified water usage (assumed delivery point capacity)	12.5%	10%	5.3%	5%
Environmental impacts/benefits and sustainability	20%	20%	21.1%	10%	Minimizing carbon footprint (energy use as a surrogate) Environmental and social justice Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area Equity in supply benefits (with respect to water rights)	5%	5%	5.3%	2.5%
Ease of implementation and regulatory compliance	15%	20%	31.6%	10%	Willing partner(s) interested in collaborating Ease of public health regulatory compliance Ease of environmental discharge regulatory compliance Design readiness Anticipated permit requirements Public acceptance/support	2.5%	3.3%	5.3%	1.7%
Engineering feasibility	15%	20%	26.3%	10%	Need for pilot study (treatment technology proven at full scale) Ease of pipeline construction Land acquisition/ownership Site preparation requirements Ease of operation	3%	4%	5.3%	2%



(a) (b)

(c) (d)

Figure 1-1. Evaluation results using: (a) criteria weights from October 2018 PPG meeting, (b) equal criteria weights, (c) equal sub-criteria weights, and (d) heavily weighted toward economics

1.2 Portfolio Comparison

The following high-level narrative compares key aspects of North County portfolios as rooted in the CoRe Plan objectives and guiding principles.

1.2.1 Economics

In scoring portfolios by economics, this analysis uses two sub-criteria:

1. **Unit cost of projected water yield in dollars per AF, 30-year life cycle –** This quantitative sub-criterion favors the three lowest-cost portfolios, 1c (SJ TWA [Milpitas Pipeline]), 1a (SJ GWR), and 1d (SJ TWA [new pipeline]), with 1b (SJ RWA) following closely behind. Portfolio 4 (PA/SV GWR) scores the lowest as it has the highest unit cost in dollars per AF.
2. **Estimated life-cycle costs, 30-year life cycle present value –** 1c (SJ TWA [Milpitas Pipeline]) scores the highest, as it has the lowest 30-year life-cycle present value, and 4 (PA/SV GWR) scores the lowest.

1.2.2 Countywide (Regional) Supply Reliability

The countywide (regional) supply reliability criterion looks at:

1. **Anticipated PR annual yield using lower-bound flow projection –** San Jose Portfolios score the highest as they likely have adequate source water[1] to reach the 24,000 acre-feet per year (AFY) PR goal. Portfolios 2a: PA (+SV) GWR, 2b (SV [+PA] GWR), and 4 (PA/SV GWR) have more uncertainty about flow availability: the Project Team assumed an annual PR yield of 17,000 AFY using lower-bound (or flat-line) flow projections. See Appendix A-2 for details about flow calculation assumptions.
2. **Purified water usage (assumed delivery point capacity) –** Portfolios 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) score the highest using delivery point capacity assumptions outlined in Appendix A-2.

1.2.3 Environmental Impacts/Benefits and Sustainability

This criterion is made up of four sub-criteria:

1. **Minimizing carbon footprint** (using energy use as a surrogate for greenhouse gas emissions) – Energy use, including AWPF and pump station annual electricity use but not ROC Management energy use, is between 67,100 megawatt-hours (MWh) per year and 80,300 MWh per year for all portfolios. 1a (SJ GWR) has the lowest energy use and scores the highest, followed by 2b (SV [+PA] GWR). Portfolio 1b (SJ RWA) uses the most energy and scores the lowest because of additional AWPF energy use from ozone-biological activated carbon (BAC) processes used for RWA and TWA (but not GWR), and significant pump energy to bring water uphill to Penitencia WTP. 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) use less energy than 1b (SJ RWA) due to reduced pumping energy.
2. **Environmental and social justice –** Scores for environmental and social justice are based on perceived equity in resource allocation, such as negative impacts of reuse affecting low-income or minority areas (i.e., communities planned to receive purified water as part of their drinking water supply, and communities in close proximity to facilities/construction). 1a (SJ GWR), 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) would build AWPFs in an area far away from surrounding communities, whereas Portfolios 2a (PA [+SV] GWR), 2b (SV

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[1] Source water negotiations are currently ongoing. The ease of implementation criterion includes partnerships/agreements.

[+PA] GWR), and 4 (PA/SV GWR) have AWPF locations closer to lower-income, minority areas that might be affected by the construction. 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) will serve TWA water along the East Pipeline that includes disadvantaged areas of San José.[2]

3. **Local reuse benefit – recycled water producers (WWTPs) directly benefit by retaining reuse supply in own service area** – Portfolios 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) receive the highest score because RWA and TWA delivery points are in areas of San José that are fully within the San José/Santa Clara Regional Wastewater Facility (SJ/SC RWF) service area. 1a (SJ GWR) receives a moderate score because once purified water is injected into LGRP, some of it may be used for purposes that don't directly benefit the immediate SJ.SC RWF service area. 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR) receive lower scores because, as GWR projects, each will benefit the entire groundwater basin rather than just the respective service area. In addition, Palo Alto does not use currently groundwater for potable supply, so Palo Alto customers would not see a direct water supply benefit under current conditions.
4. **Equity in supply benefits (with respect to water rights)** – Portfolios 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR) receive the highest score because they take source water from wastewater service areas with secure water rights and recharge the groundwater to benefit customers throughout North County (including areas will less secure water rights). 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) receive moderate scores: they have a neutral impact on equity because RWA and TWA keep supply within the same service area. 1a (SJ GWR) takes supply from the least "water secure" area within North County and sends it for groundwater recharge to benefit customers throughout North County (including areas with more secure water rights).

1.2.4 Ease of Implementation and Permitting/Regulatory Considerations

Implementation and permitting/regulatory considerations pertain to the following six sub-criteria:

1. **Willing partner(s) interested in collaborating** – Portfolio 2a (PA [+SV] GWR) scores well due to an existing long-term agreement between Valley Water and Palo Alto regarding source water supply for reuse and siting a regional facility somewhere in Palo Alto. Portfolios 2b (SV [+PA] GWR) and 4 (PA/SV GWR) require a source water / facility siting agreement with Sunnyvale, which is still under negotiation. Portfolios 1a (SJ GWR), 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) rely on source water from South Bay Water Recycling (SBWR), which is contingent (in part) on addressing long-term potable water supply needs in North San José and Santa Clara. As of early April 2021, an agreement is under negotiation between SBWR and Valley Water.
2. **Ease of public health regulatory compliance** – The GWR portfolios (1a, 2a, 2b, 4) receive the highest score because these GWR portfolios have the easiest regulatory compliance path ahead with respect to pathogens, chemicals, source control, monitoring and control, retention and response time, and TMF capacity. All direct potable reuse (DPR) options performed lower than GWR portfolios on TMF capacity, as it could be challenging to fill operator staff positions. 1b (SJ RWA) performed better than 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) with respect to chemicals, as its RWA supply benefits from passing through a WTP before water is sent to customers. 1c (SJ TWA [Milpitas Pipeline]) receives the lowest score because it uses an existing pipeline (the Milpitas Pipeline) to send water to Valley Water distribution systems: an existing pipeline is more challenging to monitor than a new pipeline (as included in 1d (SJ TWA

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[2] The Project Team used the California Department of Water Resources Disadvantaged Communities Mapping Tool to locate disadvantaged communities (using the Block Group 2016 layer); https://gis.water.ca.gov/app/dacs/

[new pipeline])). Table 1-3 includes additional details about Portfolios' anticipated regulatory complexity related to public health considerations.

3. **Ease of environmental discharge regulatory compliance** – 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) receive the highest score for environmental discharge as these have no environmental discharges under normal operating conditions (although each may be designed with an option for discharge to streams or to surface or groundwater reservoirs for maximum utilization; scoring should be updated if such discharges are planned for a more accurate comparison). Portfolios 1a (SJ GWR), 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR) receive moderate scores because they have low regulatory complexity related to environmental discharges, but still have to meet compliance requirements in discharging purified water to LGRP.
4. **Design readiness** – 1a (SJ GWR) receives the highest score for this sub-criterion due to the volume of study done by Valley Water's Expedited Purified Water Program Plan (Expedited Plan) on a GWR option using an AWPF located in San Jose. The Expedited Plan also examined a scenario similar to 1b (SJ RWA) for RWA, although the detail is less than for the GWR scenario (i.e., 1a (SJ GWR)). Portfolios 1c (SJ TWA [Milpitas Pipeline]), 1d (SJ TWA [new pipeline]), 2a (PA [+SV] GWR), 2b (SV [+PA] GWR) and 4 (PA/SV GWR) are new to the CoRe Plan and receive lower scores.
5. **Anticipated permit requirements** – Portfolio 2a (PA [+SV] GWR) receives the highest score based on having the fewest anticipated NEPA/CEQA permit requirements (it is the least likely portfolio to require a U.S. Fish and Wildlife Service (USFWS) Section 7 permit or a Cultural Resources permit).
6. **Public acceptance/support** – The public acceptance sub-criterion is based on the assumed difficulty in getting public buy-in on portfolio element designs and the location of new facilities. More detailed polls of Santa Clara County residents are recommended to further inform this assumption. 1a (SJ GWR) and 2a (PA [+SV] GWR) both receive high scores, as the AWPF technologies recommended are not new and could be justified to the public, and the proposed AWPF locations are likely to be supported by the public at large. It is assumed that the public would have the lowest support for TWA AWPFs in Portfolios 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]), followed by an RWA AWPF, such as the treatment facility in 1b (SJ RWA). Portfolios 2b (SV [+PA] GWR) and 4 (PA/SV GWR) are scored moderately because there could be public push-back against the Recycle Hill site or other Sunnyvale locations.

1.2.5 Engineering Feasibility

This criterion is made up of five sub-criteria:

1. **Need for pilot study** – 1a (SJ GWR), 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR) receive the high score because treatment technologies used would mirror technologies used at Silicon Valley Advanced Water Purification Center (SVAWPC) that are tested at scale and would not require a pilot study.
2. **Ease of pipeline construction** – 1a (SJ GWR) scores highly for this sub-criterion because it avoids crowded utility corridors and high-traffic areas that are of concern for Portfolios 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR). Portfolios 1b (SJ RWA), 1c (SJ TWA [Milpitas Pipeline]), and 1d (SJ TWA [new pipeline]) are also expected to have challenges with crossings and high-traffic areas.
3. **Land acquisition/ownership** – Portfolios 1a (SJ GWR) through 1d (SJ TWA [new pipeline]) and 2b (SV [+PA] GWR) score highly for this sub-criterion because land is available in the area near the SJ/SC RWF and near the Sunnyvale Water Pollution Control Plant (WPCP). Portfolios 2a (PA [+SV]

GWR) and 4 (PA/SV GWR) score lower because the site Palo Alto has identified for a potential regional AWPF requires voter approval for use of the land.

4. **Site preparation requirements** – Portfolios 1a (SJ GWR) through 1d and Portfolio 2a (PA [+SV] GWR) score highly for this sub-criterion because land identified for these projects would not require significant site work prior to construction. Portfolios 2b (SV [+PA] GWR) and 4 (PA/SV GWR) score lower because the site Sunnyvale has identified for a regional AWPF is a former landfill with unknown contaminants.
5. **Ease of Operation** – Portfolios 1a (SJ GWR), 2a (PA [+SV] GWR), 2b (SV [+PA] GWR), and 4 (PA/SV GWR) score highly for this sub-criterion because Valley Water already has experience operating SVAWPC. Portfolios 1c (SJ TWA [Milpitas Pipeline]) and 1d (SJ TWA [new pipeline]) are the least favored because operating a TWA facility offers new and unique challenges. 1b (SJ RWA) receives a moderate score because an RWA facility would be more difficult to operate than a GWR facility.

1.3 South County Reuse Options Evaluation

South County reuse scenarios considered include NPR from South County Regional Wastewater Authority (SCRWA) (for comparison only), Option 1: NPR+ via SBWR (MH-1: NPR+), Option 2: a Morgan Hill satellite WWTP and AWPF used for GWR at existing percolation ponds (MH-2: GWR), and Option 3: a Morgan Hill satellite WWTP and AWPF used for SWA at Anderson Reservoir (MH-3: SWA). These South County options can be combined with any portfolio and, therefore, are evaluated separately. Tables 1-8 and 1-9 illustrate a basic side-by-side comparison of how the NPR/NPR+ options and the GWR vs. SWA options perform with respect to the five criteria, with green shading indicating the more favorable. A qualitative discussion of the results follows.

Table 1-8. South County NPR Element Qualitative Comparison

Criteria	Reference: Morgan Hill NPR from SCRWA	MH-1: NPR+ (from SBWR)
Economics		🟩
Groundwater management and Countywide (regional) supply reliability		🟩
Environmental impacts/benefits and sustainability		🟩
Ease of implementation and permitting/ regulatory considerations	🟩	
Engineering feasibility	🟩	🟩

Green shading = more favorable. In the case of engineering feasibility, the options each have unique challenges and neither came out significantly ahead.

Table 1-9. South County PR Element Qualitative Comparison

Criteria	MH-2: GWR	MH-3: SWA
Economics	🟩	
Groundwater management and Countywide (regional) supply reliability		🟩
Environmental impacts/benefits and sustainability		🟩
Ease of implementation and permitting/ regulatory considerations	🟩	
Engineering feasibility	🟩	

Green shading = more favorable

1.3.1 Economics

The cost of NPR/NPR+ in South County is similar to several other NPR/NPR+ expansion options in North County. MH-1 (NPR+) has a 30-year life-cycle unit cost of $2,200/AF. Although this study did not calculate a life-cycle unit cost for the NPR from SCRWA option, both capital and O&M costs are higher for the SCRWA option than for MH-1 (NPR+). Therefore, MH-1 (NPR+) scores higher than NPR from SCRWA for economics. As shown in Sections 3.2 and 4.1 of Appendix A-1, the 30-year and 100-year life-cycle costs for the South County PR elements are high relative to the supply yield: MH-2 (GWR) has a 30-year life-cycle unit cost of $6,100/AF, and MH-3 (SWA) has a 30-year life-cycle unit cost of $7,000/AF. MH-2 (GWR) scores higher due to its lower relative cost, but both have higher unit costs than North County portfolios.

1.3.2 Groundwater Management and Countywide (Regional) Supply Reliability

South County projects provide moderate benefit for Countywide (regional) supply reliability. Although none of the projects makes a significant contribution toward Valley Water's reuse goals and supply would be highly seasonal, any NPR or PR water used in South County helps offset groundwater use, which provides groundwater management benefits and increased local supply reliability. MH-1 (NPR+) scores higher than NPR from SCRWA because connecting two otherwise hydrologically separate areas, North County and South County, with an NPR+ pipeline could have supply and drought reliability benefits. MH-2 (GWR) is limited in the number of groundwater delivery points due to the density of potable wells in the area. Although MH-3 (SWA) does not provide a direct groundwater recharge delivery point, it augments local surface water when supply is available and would be able to use that supply, at least in theory, to recharge the groundwater basin when needed. MH-3 (SWA) performs similarly with respect to the groundwater management sub-criteria but has more delivery points than MH-2 (GWR), and therefore receives a higher score.

1.3.3 Environmental Impacts/Benefits and Sustainability

Environmental impacts relating to CEQA/NEPA were evaluated for North County portfolios as part of the ROC Management study (Appendix G) but not for South County options; however, it is anticipated that the longer pipelines and greater elevation gain of the concept to pump NPR supply from SCRWA leads to greater energy use and more CEQA/NEPA impacts. Thus, it earns a lower score for this criterion than MH-1 (NPR+).

The main difference between the two PR projects is also related to conveyance. MH-3 (SWA) includes twice as long of a pipeline and ~560 feet of elevation gain (compared to ~48 feet for MH-2 [GWR]). Therefore, MH-2 (GWR) scores higher for this criterion than MH-3 (SWA).

1.3.4 Ease of Implementation and Permitting/Regulatory Considerations

MH-1 (NPR+), performs less favorably compared to NPR from SCRWA in at least three areas:

1. Partnerships – SBWR, Valley Water, and Morgan Hill would need to reach agreement to terms of a supply agreement
2. Ownership of wastewater – San José would lose ownership when sending NPR+ supply to Morgan Hill
3. Operational simplicity – Adding another large supply area to SBWR's system could lead to operational challenges.

Public support, environmental justice issues, and permitting/compliance are not anticipated to differ greatly between the two options. Timing/readiness to proceed might give a slight advantage to MH-1 (NPR+) over NPR from SCRWA. Overall, for this criterion, NPR from SCRWA receives a higher score than MH-1 (NPR+).

For PR projects, MH-2 (GWR) outperforms MH-3 (SWA) due to operational simplicity and timing (readiness to proceed). MH-3 (SWA) scores higher for public support than MH-2 (GWR), as GWR would need to displace existing potable wells in order to perform GWR in Morgan Hill. Overall, MH-2 (GWR) is still on top.

1.3.5 Engineering Feasibility

The PR sub-criteria used for the North County portfolio comparison are not relevant to the comparison of NPR options in Morgan Hill. However, a qualitative comparison of engineering feasibility of MH-1 (NPR+) and the NPR option using SCRWA flows indicated that each have unique engineering challenges such as the construction of new transmission and distribution pipelines and inter-agency coordination for system operations and maintenance.

For PR projects, MH-2 (GWR) outperforms MH-3 (SWA) due to its lower project complexity and established precedent (i.e., GWR is more common than SWA in California to date).

Section 2: Risk Assessment

Risks for each portfolio are assessed separately from the overall evaluation to provide a focused review of aspects that may disrupt, delay, or halt projects. This assessment considers each portfolio in context of risks within seven categories and compiles results in a risk matrix.

2.1 Risk Identification

For the purpose of this assessment, a risk is defined as an event or outcome that could stop, slow, or otherwise hinder the planning, design, and/or construction of projects pursued as part of Valley Water's Countywide Water Reuse Master Plan (CoRe Plan). The CoRe Plan aims to manage risks through early identification and assessment, including determining the potential for the risk to occur and related consequences, mitigation approach, safeguards, and/or alternatives. Risk tolerance is a term used in the financial sector to refer to an investor's willingness to accept loss. Similarly, Countywide reuse program partners have varying risk tolerances that may range depending on specific context, agency goals, and other variables. When establishing partnership agreements and selecting project elements to implement, an important early step will involve defining respective risk tolerances of Valley Water and participating Partner Agencies.

The Project Team identified risks within the following seven categories through input from water reuse subject matter experts, reuse industry guidance (such as Water Research Foundation's Reference Manual 4715; Water Research Foundation, 2019), and risks discussed during meetings between Valley Water and Partner Agencies.

1. Public support:
    - Lack of understanding among public, leading to skepticism or opposition to potable reuse as a drinking water supply and/or associated rate increases
    - Public opposition to locations of new facilities
2. Partnership:
    - Challenges in inter-agency coordination and collaboration related to project implementation (e.g., roles, responsibility, ownership)
    - Terms of new agreements for source water not reached
3. Regulatory/permitting:
    - Ambiguity in requirements for DPR, including RWA and TWA, due to current lack of established regulations
    - Inability to permit from public health perspective (Division of Drinking Water [DDW] approval) for scenarios where regulations exist (i.e., NPR and indirect potable reuse [IPR]) or for DPR, once regulations are established
    - Lack of access to cost-effective management strategies for residual streams (i.e., RO concentrate)
    - Inability to permit discharges (e.g., ROC Management)
4. Operations:
    - Lack of certified operators for advanced treatment (both short and long term)
    - Inconsistent facility flow/supply yield due to diurnal patterns, seasonal variations, and/or climatic conditions
    - Inability to use purified water to extent anticipated due to limitations of delivery points (e.g., groundwater basin conditions)
    - Challenge in coordinated operations for projects involving interconnected systems
5. Source water supply availability:
    - Uncertainty in future WWTP effluent available for reuse (based on lower WWTP influent and/or higher NPR demands, environmental flows, or greater seasonality or diurnal variations in flow)

6. Funding:
   - Inability to fund program; limited grant funding opportunities (including terms precluding potential private-public partnership from receiving public grant funds); lack of revenue certainty; and/or lack of agreement for cost sharing
7. Distribution system:
   - Potential for water quality problems such as water chemistry changes due to introduction of PR supply and corrosion control issues, or cross-connection risks of NPR

2.2 Risk Analysis

The Project Team qualitatively analyzed risks related to each portfolio/option considering the likelihood and consequence(s) of a particular risk occurring and mitigation strategies that could eliminate the risk or reduce its impact. Figure 2-1 presents an example of portfolio/option performance with respect to risk likelihood on the horizontal axis and risk consequence on the vertical axis. Likelihood and consequence scores are combined for the risk categories such that each portfolio/option has a single risk likelihood and risk consequence score. Prior to finalizing results from the risk tool, the Project Team plans to get feedback from Valley Water and Partner Agencies on individual risk category scores for the portfolios and options.

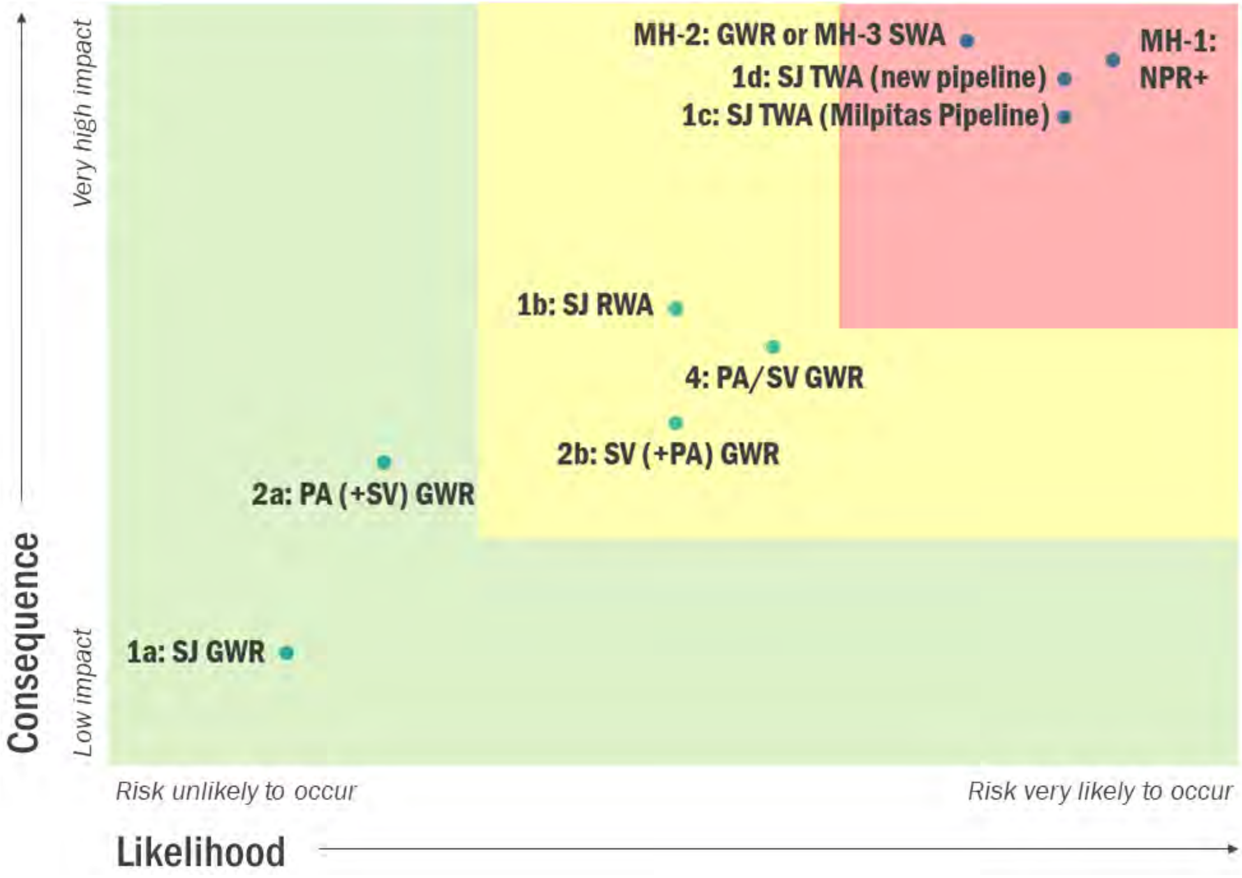

Figure 2-1. Example Risk Matrix comparison of portfolios and options indicating the likelihood of risk occurring on the x-axis and consequence of risk occurring on the y-axis

The Project Team also analyzed how portfolios/options compare using a qualitative risk score defined as the product of risk likelihood and risk consequence. Each score was then assigned a rating of low, medium, high and very high (Table 2-1).

Table 2-1. Risk Score Key[a]

			Consequence			
	Rating	Scoring Factor	Low Significance	Medium Significance	High Significance	Very High Significance
			1	2	3	4
Likelihood	Low	1	Low	Low	Medium	Medium
	Medium	2	Low	Medium	Medium	High
	High	3	Medium	Medium	High	High
	Very High	4	Medium	High	High	Very High

*a. Risk scores are the product of (consequence * likelihood) factors.*

🟥 = *Very High risk*

🟥 = *High risk*

🟨 = *Medium risk*

🟩 = *Low risk*

Example risk scores for each portfolio/option with respect to all individual risk categories are shown in Table 2-2. As stated above, the risk scoring requires input from Valley Water and Partner Agencies prior to finalization.

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Table 2-2. Risk Matrix: Relative Comparison of Risks for North County Portfolios and South County Options

Category	Risk Description	Potential Consequences (Conditions/Events)	1a: SJ GWR	1b: SJ RWA	1c: SJ TWA (Milpitas Pipeline)	1d: SJ TWA (new pipeline)	2a: PA (+SV) GWR	2b: SV (+PA) GWR	4: PA/SV GWR	MH-1: NPR+	MH-2 GWR or MH-3 SWA
1. Public support	Lack of public understanding, leading to skepticism or opposition to water reuse as a drinking water supply and/or associated rate increases	Potential to erode support from publicly elected decision makers, and ultimately slow or stop program/project construction	Medium	High	Very High	Very High	Medium	Medium	Medium	Medium	High
	Public opposition to location(s) of new facilities.		Low	Low	Low	Low	Low	Medium	Medium	Very High	Medium
2. Partnerships	Challenges in inter-agency coordination and collaboration related to project implementation (e.g., roles, responsibility, ownership)	Delayed or cancelled program/project construction due to not reaching agreement terms	High	High	High	High	Medium	Medium	Medium	Very High	Medium
	Terms of new agreements for source water not reached	Lower yield than planned for dry year supply reliability and/or delayed or cancelled program/project construction due to source water unavailability for planned reuse project(s)	High	High	High	High	Low	Medium	Medium	Very High	High
3. Regulatory/permits	Ambiguity in DPR requirements, including RWA and TWA, due to current lack of established regulations	Increased project cost to meet requirements; delayed or cancelled program/project construction due to changes needed to details/design of project	Low	High	Very High	Very High	Low	Low	Low	Low	Low
	Inability to permit from public health perspective (DDW approval) for scenarios where regulations exist (i.e., NPR and IPR) or for DPR, once regulations are established		Low	Medium	High	High	Medium	Medium	Medium	Low	High
	Lack of access to cost-effective management strategies for residual streams (i.e., ROC)		Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High
	Inability to permit discharges (i.e., ROC Management)		Medium	High	High	High	Medium	Medium	Medium	Low	High
4. Operations	Lack of certified operators for advanced treatment (over long term)	Delay in operating project(s), inability to realize anticipated yield for dry year reliability	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium	Medium
	Inconsistent facility flow/supply yield due to diurnal patterns, seasonal variations, and/or climatic conditions	Compromised reuse goals, underused assets, increased O&M costs and equipment problems	Low	Low	Low	Low	Medium	Medium	Medium	High	High
	Inability to use recycled/purified water to extent anticipated due to limitations of delivery points (e.g., groundwater basin conditions)		Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Challenge in coordinated operations for projects involving interconnected systems		Low	Low	Low	Low	Medium	Medium	Medium	High	Low
5. Source water supply availability	Uncertainty in future WWTP effluent available for reuse	Compromised reuse goals, underused assets/ oversized facilities	Low	Low	Low	Low	High	High	High	Very High	High
6. Funding	Inability to fund program; limited grant funding opportunities (including terms precluding potential private-public partnership from receiving public grant funds); lack of revenue certainty; and/or lack of agreement for cost sharing	Delayed or cancelled program/project construction; inability to recover costs	Low	Medium	Low	Medium	Medium	Medium	Medium	Medium	High
7. Distribution system issues	Water quality problems: (1) introducing new sources of potable supply may change water chemistry and potentially disrupt corrosion control (2) new NPR lines risk cross-connections	Public health risks, including exposure to contamination from: (1) lead (2) pathogens	Low	Medium	High	High	Low	Low	Low	Medium	Medium

🟥 = *Very High risk*
🟪 = *High risk*
🟨 = *Medium risk*
🟩 = *Low risk*

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2.3 Risk Mitigation

Methods to manage risks are identified by risk category, as follows.

1. Public support:
   - Collaborate with Partner Agencies to develop and implement a framework for consistent regional public outreach related to potable reuse
   - Build stakeholder support early in program planning process and engage champions
   - Increase use of SVAWPC as a tool to educate the public
   - Work with public figures and media outlets to inform messaging about PR
   - Collaborate to establish best practices for testing water quality within reuse distribution systems
   - Involve public and stakeholders early in planning process to keep local residents aware of planned facilities (particularly if located near residences, office buildings, and recreation areas) to avoid potential opposition when applying for permits
2. Partnership:
   - Consider agreements that allow for integrated, holistic solutions
   - Establish effective communication and collaboration venues among agencies at technical, operational, and managerial levels
   - Consider interim agreements (e.g., incremental progress, shorter duration) if longer or more complex agreements are too hard to reach
   - Use third-party mediation and/or facilitation
3. Regulatory/permitting:
   - Communicate early and often with regulators to determine permitting requirements for PR
   - Involve an Independent Advisory Panel to assess technologies and approaches to protect public health
   - Seek innovative technologies and permitting approaches to manage ROC quantity and quality
4. Operations:
   - Support operators in obtaining advanced water treatment certification
   - Construct more storage and/or use groundwater banking to shield against lower flows
5. Source water supply:
   - Identify trends pertaining to source water availability and NPR use, and identify factors and uncertainties influencing future projections
   - Construct more storage and/or use groundwater banking to shield against lower flows
   - Identify alternate sources of water supply if possible

6. Funding:
   - Establish a contingency plan for funding in case primary funding source is compromised
   - Implement program by prioritizing projects and enabling modular construction to incrementally increase facility capacity (as possible) to stretch ratepayer funds to yield the maximum possible benefit and reduce likelihood of constructing underused assets
7. Distribution system:
   - Perform tests to simulate new blended water conditions and impacts on pipes
   - Implement robust cross-connection prevention programs; enforce purple pipe, signage and labelling rules; and target public communication/ awareness campaigns to developers, plumbers, and others

Section 3: Key Findings and Next Steps

The evaluation and risk assessment come to similar conclusions. Portfolios 1a (SJ GWR) and 2a (PA [+SV] GWR) are most well-balanced and perform favorably in scoring based on prioritization criteria and risk categories. 1b (SJ RWA) also performed well in the evaluation, consistently ranking in the top three of five North County portfolios across various weighting scenarios.

South County options were evaluated separately. As part of the risk analysis, NPR+ sourced from SBWR for distribution in Morgan Hill carries high risk, as does a satellite treatment facility for potable reuse. The lack of a long-term agreement for use of the Silver Creek Pipeline could prevent MH-1 (NPR+) from being implemented, which impacted the risk score.

Valley Water, in coordination with Partner Agencies and other stakeholders, may use the evaluation and risk tools in next steps such as environmental review and project selection.

Appendix A-8: Treated Water Augmentation Pre-Screening Analysis

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Valley Water

MEMORANDUM

FC 14 (08-21-19)

TO: Hossein Ashktorab, Ph.D.
Recycled and Purified Water Unit Manager

FROM: Zach Helsley, P.E.

SUBJECT: Treated Water Augmentation Pre-Screening Analysis

DATE: May 22, 2020

This memorandum summarizes conceptual cost estimates developed by staff of eight expanded Treated Water Augmentation (TWA) alternatives originally presented in the TWA Addendum to D7[1] (TWA Addendum).

OBJECTIVES

The objectives of this analysis were to:

1) expand on TWA concepts identified in the TWA Addendum developed by Brown and Caldwell (BC) for the Countywide Water Reuse Master Plan (CWRMP) and develop conceptual cost estimates for treatment facilities, conveyance, pumping, and reverse osmosis concentrate management; and,
2) develop a recommendation for preferred alternatives for in-depth engineering design and cost estimation as part of the CWRMP.

BACKGROUND

Valley Water has undertaken the development of a CWRMP to evaluate potential potable and non-potable water reuse projects in Santa Clara County. The CWRMP will provide a framework for collaborative decision making that will guide project selection to best increase the region's water supply reliability through water reuse.

Previous engineering evaluations and stakeholder engagement have focused on weighing potential groundwater augmentation and raw water augmentation alternatives using treated wastewater from the four wastewater treatment facilities in the county. In August 2019, the State Water Resources Control Board Division of Drinking Water (DDW) released the Second Edition of a *Proposed Framework for Regulating Direct Potable Reuse in California* (Framework). The Second Edition of the Framework outlined DDW's intent to develop regulations for both raw water augmentation and TWA in parallel. DDW indicated their intent to develop a single combined regulatory package by December 2023. With regulations for TWA forthcoming, the CWRMP has expanded its scope[2] of feasible projects to include evaluation of TWA opportunities in the county.

Based on input received May 20, 2019 from Valley Water's Recycled Water Committee, the CWRMP team developed several versions of draft TWA conceptual options which were summarized in the TWA Addendum. These draft options were shared with stakeholders for input during one-on-one meetings in December 2019 through February 2020 and during the Project Partner Group (PPG) meeting #6 on February 24, 2020. The PPG generally expressed positive interest to proceed with all TWA options for further analysis.

To assist in selecting up to three TWA options for further analysis, staff was directed to further refine the original five TWA concepts and prepare conceptual cost estimates.

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[1] *DRAFT Treated Water Augmentation (TWA) Addendum to D7*. Brown and Caldwell. February 19, 2020

[2] Amendment No. 2 to A4120A CAS File No. 4821 Countywide Water Reuse Master Plan. December 18, 2019

ASSUMPTIONS

In order to facilitate development of conceptual cost estimates for the expanded TWA concepts, several assumptions were made regarding requirements for blending with potable water, treatment processes, constructability, etc. General assumptions common to all TWA concepts are as follows (concept specific assumptions are detailed in following sections):

1. All alternatives assume that no blending of TWA water with other potable water sources will be required at the identified receptors.
2. Costs for right-of-way or real estate acquisitions were not included.
3. Costs associated with purchase or transfer of advanced water purification facility (AWPF) source water (i.e. treated wastewater) were not included.
4. The treatment process for proposed TWA AWPFs is assumed to be the same as the RWA AWPF described in the CWRMP Portfolio 1B[3], and will include tertiary treated wastewater, ozone-biologically active carbon, ultrafiltration, reverse osmosis, ultraviolet light – advanced oxidation, and chlorine disinfection. It is assumed that his configuration will comply with the forthcoming TWA regulations. The assumed TWA train adds an 8-hour clearwell to the RWA train. Since clearwell costs were not readily available, RWA costs were used in this screening.
5. No allowances have been made for additional storage or blending facilities at TWA receptors.
6. This analysis does not consider potential back-up/ alternative potable water sources, nor does it attempt to quantify the amount of TWA water that is delivered to existing treated water turnouts.
7. Pipeline alignments, AWPF treatment processes, need for purified water storage/blending structures are subject to revision by the CWRMP team as additional engineering analysis is complete. This additional analysis may change costs presented in this memorandum.

METHODOLOGY

First, the capital and annual operations and maintenance (O&M) costs for treatment, pipelines, pump stations, and reverse osmosis concentrate were estimated. Then, a simplified analysis of project lifecycle was conducted to compute estimated unit costs ($/AFY) for each concept.

Advanced Water Treatment Facilities

Costs for AWPFs were computed using a scaling factor derived from the capital and annual O&M costs for the 24 million gallon per day (MGD) AWPF in the CWRMP Portfolio 1B. The scaling factors can be found in Table 1. TWA AWPF costs were calculated by multiplying the scaling factor by the proposed capacity of the TWA AWPF. Costs for AWPFs proposed in Gilroy and Morgan Hill were estimated based on related engineering studies.

Table 1. Capital and O&M Scaling Factors

	24 MGD AWPF[a] ($M)	Scaling Factor ($M/MGD)
Capital Costs	369	15.38
Annual O&M	13.8	0.58

a. Source: *Deliverable 7 Feasible Project Portfolios Attachment D – Cost Estimates.* Table D-15 San José AWPF; 24 MGD for RWA (Portfolio 1b). Brown and Caldwell. February 19, 2020

Purified Water Pipelines

BC provided planning documentation for the purified water pipeline alignments developed for the TWA Addendum. As the original TWA concepts were refined, staff used Google Earth Pro and ESRI ArcGIS to develop purified water pipeline alignments for new scenarios and identify associated elevation changes and distances. Costs were developed using parametric costing factors used in the CWRMP[4]. New alignments, when required, were routed to follow major roadways and other public rights-of-way.

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[3] *Deliverable 7 Feasible Project Portfolios*. Section 2.1.3.3 Raw Water Augmentation. Brown and Caldwell. February 19, 2020

[4] *Deliverable 7 Feasible Project Portfolios Attachment C – Basis of Cost*. Table C-5 Conveyance Unit Cost Estimates Rate (%). Brown and Caldwell. February 19, 2020.

Trenchless construction was assumed when crossing large roadways, highways, railroad tracks, and creeks. Pipe sizes were chosen to keep fluid velocity below 5 feet per second.

Pump Stations

When pump stations were previously sized for similar flows as part of CWRMP D7, corresponding capital and annual O&M costs were used. For new pump stations, capital costs were computed using a scaling factor derived from the average capital costs and indicated horsepower for all pump stations develop in CWRMP D7. Horsepower requirements for new pump stations were estimated using the total hydraulic head based on the elevation difference at the start and end of the longest pipeline segment and frictional losses, an assumed 70% pump efficiency, and 90% motor efficiency. Annual O&M was calculated as 8% of the estimated capital cost.

RO Concentrate Management

RO concentrate management costs were adapted from the March 6, 2020 version of *Task 4 – Evaluation of ROC Management Options* Technical Memorandum. The primary management strategies for each respective AWPF location were used for this analysis. When new AWPFs were proposed, RO concentrate management strategies were resized using a power scaling factor with an R value of 0.6. Table 2 details the RO concentrate management strategies proposed for each site.

Table 2. RO Concentrate Management Strategies

AWPF Location	Primary Management Strategy[a]
Near San José-Santa Clara Regional Wastewater Facility	Discharge past Artesian Slough weir under a separate permit
Former Los Altos Treatment Plant (LATP)	Blend and discharge using existing outfall at Palo Alto Water Quality Control Plant (WQCP)
Near Sunnyvale Water Pollution Control Plant (WPCP)	Discharge to new shallow water outfall at Guadalupe Slough
City of Morgan Hill/ South County Regional Wastewater Authority (SCRWA)	Evaporation Ponds

a. *Task 4 – Evaluation of ROC Management Options*. Table 5.1 CAPEX and OPEX Estimates for ROC Management Options. GHD Inc. March 6, 2020

Lifecycle Assessment

Lifecycle costs and unit costs were calculated by scaling the replacement and renewal (R&R) costs for the Portfolio 1B by the ratio of the proposed TWA option total capital cost to the Portfolio 1B capital cost. Similar to Portfolio 1B, the long-term purified water yield was assumed to be 87% of production capacity. Construction was assumed to take four years and begin in 2024. Construction costs were distributed evenly over the four years. A real discount rate of 2.4% was used for present value calculations.

REFINED TWA CONCEPTS

Staff has explored and expanded the original five TWA conceptual options to include thirteen refined TWA options. Table 3 provides an overview of the refined TWA options.

Table 3. Overview of Refined TWA Options

Option No.	TWA Alternative	AWPF Location	AWPF Capacity (MGD)	TWA Receptor
1	TWA-1A	San José	24	Gibraltar Reservoir/ Intertie City of San José (North of 101) City of Santa Clara (North of 101)
2	TWA-1B			Gibraltar Reservoir/ Intertie
3	TWA-7A			Piedmont Valve Yard City of San José (North of 101) City of Santa Clara (North of 101)
4	TWA-7B			Piedmont Valve Yard
5	TWA-2	Former LATP	7	City of Palo Alto Miramonte Reservoir/ Valley Water
6	TWA-6A		24	Proposed West Pipeline extension
7	TWA-6A Alt			Proposed West Pipeline Extension Terminus – excluding cost of West Pipeline expansion
8	TWA-6B			Existing West Pipeline
9	TWA-3A	Sunnyvale	7	Serra Tanks via Wolf Rd.
10	TWA-3A Alt			Serra Tanks via Wolf Rd. with parallel purified water pipeline to San Lucar Pump Station
11	TWA-3B			City of Mountain View/ Miramonte Reservoir
12	TWA-4	Morgan Hill	1.25	City of Morgan Hill treated water distribution system
13	SWA-5[a]	SCRWA	3	Coyote Reservoir

a. SWA-5 is a surface water augmentation project

San José AWPF Options

TWA-1A – 24 MGD San José AWPF to San José/Santa Clara and Gibraltar Reservoir/ SFPUC Intertie

TWA-1A would treat available effluent from the San José-Santa Clara RWF at new AWPF near the RWF. The AWPF would produce up to 24 MGD of purified water and deliver the water to the North Side Storage Tanks to supply 4 MGD of purified water to the Cities of San José and Santa Clara. 20 MGD would be delivered to the Gibraltar Reservoir where it could be introduced to Valley Water's Milpitas Pipeline. Under normal operation, this water would flow south, and augment treated water supplies along the east side of the county. This option provides the opportunity to deliver purified water to the Gibraltar Reservoir/ intertie. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-1B – 24 MGD San José AWPF to Gibraltar Reservoir/ SFPUC Intertie

Similar to TWA-1A, TWA-1B would treat available effluent from the San José-Santa Clara RWF at a new AWPF near the RWF. All 24 MGD of purified water would be delivered to the Gibraltar Reservoir where it could be introduced to Valley Water's Milpitas Pipeline. Under normal operation, this water would flow south and augment treated water supplies along the east side of the county. This option also provides the opportunity to deliver purified water to the SFPUC/ Valley Water intertie. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-7A – 24 MGD San José AWPF to San José/Santa Clara and Piedmont Valve Yard
TWA-7A would treat available effluent from the San José-Santa Clara RWF at new AWPF near the RWF. The AWPF would produce up to 24 MGD of purified water and deliver the water to the North Side Storage Tanks to supply 4 MGD of purified water to the Cities of San José and Santa Clara. 20 MGD would be delivered to the Piedmont Valve Yard below Valley Water's Penitencia Water Treatment Plant. From the Piedmont Valve Yard, purified water could be introduced to the Milpitas Pipeline to augment treated water supplies along the east side of the county, and could be conveyed in the future through the Milpitas Intertie. Purified Water would also be conveyed south through the East Pipeline to existing treated water turnouts. If excess purified water is available, it could be introduced to Valley Water's Central Pipeline and used at the Los Gatos recharge ponds for groundwater augmentation or supplied to the Rinconada Water Treatment Plant via the Vasona Valve Yard. RO concentrate would be discharged beyond the RWF's weir in Artesian Slough under a new NPDES permit.

TWA-7B – 24 MGD San José AWPF to Piedmont Valve Yard
TWA-7B is identical to TWA-7A except that it excludes the 4 MGD of purified water being delivered to the Cities of San José and Santa Clara. All 24 MGD of purified water would be delivered to the Piedmont Valve Yard.

Former LATP Sites

TWA-2 – 7 MGD LATP AWPF to Cities of Palo Alto and Mountain View
TWA-2 is unchanged from the proposed TWA-2 identified in the TWA Addendum. TWA-2 would treat up to 7 MGD of available effluent from the Palo Alto WQCP at a new AWPF located at the former LATP site. 3 MGD of purified water would be delivered to the City of Palo Alto at a yet to be determined location. The remaining 4 MGD of purified water would be delivered to the City of Mountain View and Valley Water at the Graham Middle School Reservoir and Miramonte Reservoir. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

TWA-6A – 24 MGD LATP AWPF to Proposed West Pipeline Extension
TWA-6A considers treating up to 24 MGD of available wastewater from the Palo Alto WQCP and the Sunnyvale WPCP at a new AWPF at the former LATP site. Purified water would be delivered to the terminus of the proposed West Pipeline extension at the intersection of Page Mill Road and Foothill Expressway.

The proposed West Pipeline Extension is a water supply reliability project previously evaluated by Valley Water's Water Supply Planning Unit. The proposed project would extend the existing West Pipeline north along Foothill Expressway to intersect the San Francisco Public Utility Commission's (SFPUC) Bay Division Pipeline. A system intertie would be constructed to allow Valley Water treated water to be conveyed to the SFPUC system, or for Valley Water to receive SFPUC water at times when Valley Water treatment plants were unable to meet the county's water supply demands. The West Pipeline Extension in 2012 was estimated to cost approximately $252M[5]. This cost includes the pipeline extension of 5.6 miles of 42" diameter pipe, 9.3 miles of parallel pipe of various unspecified diameters from Granger Turnout to Rinconada Water Treatment Plant, and an intertie pump station.

Purified water introduced to the proposed West Pipeline extension would normally flow south along the West Pipeline and supplement drinking water supplies to existing turnouts. Under emergency situations, purified water could be conveyed through the new intertie to the SFPUC system. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

[5] Erin Baker. Email to Angela Cheung. *WPL Extension & Intertie*. December 31, 2014

TWA-6A Alt – 24 MGD LATP AWPF to Proposed West Pipeline Extension
TWA-6A Alt is identical to TWA-6A, except the cost of the West Pipeline Extension project was excluded.

TWA-6B – 24 MGD LATP AWPF to Existing West Pipeline
TWA-6B considers treating up to 24 MGD of available wastewater from the Palo Alto WQCP and the Sunnyvale WPCP at a new AWPF at the former LATP site. Purified water would be delivered to Valley Water's existing West Pipeline. Delivery would occur at a location of comparable pipe diameter, approximately in the vicinity of Stevens Creek Blvd. and Imperial Ave. Purified water could then be conveyed north to existing turnouts on the West Pipeline, Sunnyvale Distributary, and Mountain View Distributary. Remaining purified water could be conveyed south to existing treated water turnouts on the West Pipeline. RO concentrate would be blended with any remaining treated wastewater and discharged using the existing outfall at the Palo Alto WQCP.

Sunnyvale AWPF Options

TWA-3A – 7 MGD Sunnyvale AWPF to City of Sunnyvale and Valley Water
TWA-3A would treat up to 7 MGD of available effluent from the Sunnyvale WPCP at a new AWPF near the WPCP. Two MGD of purified water would be delivered to the Serra Storage Tanks for use by the City of Sunnyvale and Valley Water. To minimize impacts to the Sunnyvale Recycled Water System, TWA-3A includes the construction of a new purified water pipeline from the AWPF to the existing Sunnyvale recycled water distribution system pipeline that brings water to the San Lucar Pump Station. This option assumes that this portion of the Sunnyvale Recycled Water System could be repurposed to convey purified water. Customers receiving water from this section of the existing recycled water system would receive purified water, however other customers of the Sunnyvale Recycled Water System would be unaffected. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough where greater mixing and dilution could be achieved.

TWA-3A Alt – 7 MGD Sunnyvale AWPF to City of Sunnyvale and Valley Water
TWA-3A Alt is identical to TWA-3A except for a new purified water pipeline that would convey purified water parallel to the existing Sunnyvale Recycled Water System pipeline that brings water to the San Lucar Pump Station. The new parallel pipeline would allow purified water to be conveyed south to the Wolfe Road. Pipeline without impacting the Sunnyvale Recycled Water System. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough where greater mixing and dilution could be achieved.

TWA-3B – 7 MGD Sunnyvale AWPF to Cities of Mountain View, Sunnyvale, and Valley Water
TWA-3B would treat up to 7 MGD of available effluent from the Sunnyvale WPCP at a new AWPF near the WPCP. A portion of the purified water would be delivered to the City of Sunnyvale at the Mary Avenue Tanks. Additional purified water would be delivered to the City of Mountain View at the Graham Middle School Reservoir and Miramonte Reservoir. Valley Water could use the remaining purified water at the Wright Ave Tanks or Miramonte Reservoir. Individual allocations of purified water between delivery points were not established for this analysis. RO Concentrate would be discharged at a new shallow water outfall constructed in Guadalupe Slough were greater mixing and dilution could be achieved.

Morgan Hill AWPF Options

TWA-4 – 1.25 MGD Satellite Morgan Hill AWPF to Morgan Hill Treated Water Distribution System
TWA-4 is unchanged from the proposed TWA-4 identified in the TWA Addendum. A satellite AWPF would be constructed in the City of Morgan Hill and would divert untreated wastewater from the sanitary sewer. Up to 1.25 MGD of purified water would be delivered to the existing treated water distribution system. RO concentrate would be conveyed to adjacent land to be evaporated.

SCRWA AWPF Options

SWA-5 – 3 MGD SCRWA AWPF to Coyote Reservoir

SWA-5 considers treating up to 3 MGD of available wastewater from SCRWA at a new AWPF located on adjacent SCRWA property. Purified water would be delivered to Valley Water's Coyote Reservoir for surface water augmentation. Currently water in Coyote Reservoir is captured rainfall from the Coyote River watershed. Water stored in the Coyote Reservoir is released to the Coyote River, where it will flow downstream to Valley Water's Anderson Reservoir. It is assumed that the combined volume and flow through Coyote and Anderson Reservoir would provide sufficient mixing and residence time to comply with existing surface water augmentation regulations. Water in Anderson Reservoir can be used to maintain stream flow in Coyote River or be conveyed through Valley Water's Cross Valley pipeline to Calero Reservoir and ultimately its three water treatment plants. RO concentrate would be conveyed to adjacent land currently owned by SCRWA to be evaporated.

RESULTS AND RECOMMENDATIONS

Results

Conceptual cost estimates for the refined TWA options are summarized in Table 4. A comparison of 30-year lifecycle costs is found in Table 5.

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Table 4. Summary of TWA Costs

AWPF Location	San José AWPF				Former LATP AWPF				Sunnyvale AWPF			Morgan Hill AWPF	SCRWA AWPF
TWA Alternative	**TWA-1A**	**TWA-1B**	**TWA-7A**	**TWA-7B**	**TWA-2**	**TWA-6A**	**TWA-6A Alt**	**TWA-6B**	**TWA-3A**	**TWA-3A alt**	**TWA-3B**	**TWA-4**	**SWA-5**
AWPF Capacity (MGD)	24	24	24	24	7	24	24	24	7	7	7	1.4	3
Long-term Yield (AFY)	23,400	23,400	23,400	23,400	6,821	23,400	23,400	23,400	6,821	6,821	6,821	1,218	2,923
Capital Cost ($M)													
Treatment	$370	$370	$370	$370	$108	$370	$370	$370	$119	$119	$119	$50	$70
Conveyance	$78.4	$54.1	$130.8	$104.5	$73.8	$475.5[a]	$165.5	$223.9	$18.5	$41.0	$69.2	$4.0	$49.0
Pump Stations	$3.8	$3.0	$15.9	$16.8	$10.5	$21.5	$21.5	$34.8	$4.1	$4.1	$5.4	$0.2	$6.4
ROCM	$28.7	$28.7	$28.7	$28.7	$13.9	$29.0	$29.0	$29.0	$20.6	$20.6	$20.6	$22.6	$45.1
Capital Total:	$480.9	$455.8	$545.4	$520.0	$206.2	$896.0	$586.0	$657.7	$162.2	$184.7	$214.2	$76.8	$170.5
Annual O&M ($M)													
Treatment	$13.8	$13.8	$13.8	$13.8	$4.1	$13.8	$13.8	$13.8	$4.1	$4.1	$4.1	$2.0	$2.1
Conveyance	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2	$0.1	$0.2	$0.02	$0.05	$0.1	$0.01	$0.1
Pump Station	$0.3	$0.2	$1.3	$1.3	$0.8	$1.9	$1.9	$2.9	$0.3	$0.3	$0.4	$0.02	$0.5
ROCM	$0.36	$0.36	$0.36	$0.36	$0.17	$0.35	$0.35	$0.35	$0.27	$0.27	$0.27	$0.24	$0.48
Annual O&M Total:	$14.5	$14.4	$15.5	$15.6	$5.2	$16.2	$16.1	$17.3	$4.7	$4.8	$4.9	$2.3	$3.2
Life-Cycle Costs													
30-Year Life Cycle	$1,900	$1,800	$2,100	$2,000	$2,600	$3,000	$2,200	$2,400	$2,200	$2,400	$2,600	$5,800	$4,700
100-Year Life Cycle	$1,500	$1,500	$1,700	$1,600	$2,000	$2,300	$1,700	$1,900	$1,700	$1,900	$2,000	$4,500	$3,500

a. Includes $310M for West Pipeline Expansion project (escalated $252M from 2012$).

Table 5. 30-Year Life Cycle Costs (ordered lowest to highest)

Alternative	Description	Treatment Capacity (MGD)	Capital ($M)	Annual O&M ($M)	30-Year Life Cycle ($/AFY)
TWA-1B	SJ AWPF to Gibraltar Reservoir/ SFPUC Intertie	24	$455.8	$14.4	$1,800
TWA-1A	SJ AWPF to SJ/SC connection and Gibraltar Reservoir/ SFPUC Intertie	24	$480.9	$14.5	$1,900
TWA-7B	SJ AWPF to Piedmont Valve Yard	24	$520.0	$15.6	$2,000
TWA-7A	SJ AWPF to SJ/SC connection and Piedmont Valve Yard	24	$545.4	$15.5	$2,100
TWA-6A alt	LATP AWPF to proposed West Pipeline Extension Terminus – excluding cost of West Pipeline expansion	24	$586.0	$16.1	$2,200
TWA-3A	SU AWPF to Serra Tanks via Wolfe Rd.	7	$162.2	$4.7	$2,200
TWA-6B	LATP AWPF to existing West Pipeline	24	$657.7	$17.3	$2,400
TWA-3A alt	SU AWPF to Serra Tanks via Wolf Rd. with parallel purified water pipeline to San Lucar Pump Station	7	$184.7	$4.8	$2,400
TWA-3B	SU AWPF to City of Mountain View/ Miramonte Reservoir	7	$214.2	$4.9	$2,600
TWA-2	LATP AWPF to City of Mountain View and City of Palo Alto	7	$206.2	$5.2	$2,600
TWA-6A	LATP AWPF to proposed West Pipeline Extension	24	$896.0	$16.2	$3,000
SWA-5	SCRWA AWPF to Coyote Res.	3	$170.5	$3.2	$4,700
TWA-4	Morgan Hill AWPF	1.25	$76.8	$2.3	$5,800

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Recommendations

Staff has developed conceptual cost estimates for thirteen refined TWA alternatives to identify potential concepts for further engineering analysis. Evaluations were performed assuming wastewater was available, ROC management options were applicable, and TWA water could be applied at the identified receptors.

Identified TWA alternatives that deliver purified water to the East Pipeline, either at the Gibraltar Reservoir (TWA-1A and TWA-1B) or at the Piedmont Valve Yard (TWA-7A and TW-7B) were found to have the lowest life-cycle costs as a result of their ability to utilize large volumes of purified water and their lower conveyance requirements. These TWA alternatives include a number of ancillary operational benefits, including the ability to move water throughout the east side of the county, and the potential to convey purified water to the SFPUC system via the Milpitas Intertie. Therefore, staff recommends TWA-1A, TWA-1B, TWA-7A, and TWA-7B for additional engineering analysis and cost assessment as part of the CWRMP. Staff recommends these analysis should include the evaluation of actual demand and the ability of turnouts along the Milpitas and East Pipelines to utilize purified water in addition to existing treated water supplies, including refinements to purified water alignments and evaluation of storage and blending facility needs at TWA receptors.

Staff acknowledges ancillary benefits beyond conveying purified water could be realized if the proposed West Pipeline Extension assumed in TWA-6A and TWA-6A Alt was constructed, including greater operational flexibility for Valley Water's treated water conveyance and additional access to SFPUC's Bay Division Pipeline for improved reliability along the West Pipeline. Furthermore, if the construction cost to extend the West Pipeline is excluded from the alternatives analysis, the 30-year lifecycle cost is found to be competitive with the above recommended eastside alternatives. Since the proposed Westside Pipeline Extension project could have additional benefits beyond conveying potential purified water, staff recommends that further engineering and cost assessment be considered by management subject to available scope and task resources.

Respectfully,

Zachary Helley

Associate Engineer - Civil
Recycled and Purified Water Unit

cc: M. Silva, D. Tucker

LIST OF ATTACHMENTS

Attachment A – Figures of Refined TWA Options
Attachment B – Conceptual Cost Estimates

ATTACHMENT A - Figures of Refined TWA Options

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Figure 1. TWA-1A/1B and TWA-7A/7B

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[redacted]

Figure 2. TWA-2

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[redacted]

Figure 3. TWA-3A/3B

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[redacted]

Redacted from public version due to confidentiality of information shown.

[redacted]

Figure 5. SWA-5

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Figure 6. TWA-6A/6B

ATTACHMENT B – Conceptual Cost Estimates

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Table 6. Conceptual Cost Estimate Summary

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
TWA-1A - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Northside Storage Tanks	24	--	23,810	--	$31,000	$39
Purified Pipeline	San José AWPF	Gibraltar Reservoir	36	--	20,722	--	$41,000	$34
Pump Station	San José AWPF	Northside Storage Tanks	--	--	--	--	$700	$56
Pump Station	San José AWPF	Gibraltar Reservoir	--	--	--	--	$3,100	$248
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
Total:							$480,900	$14,542
TWA-1B - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$34
Purified Pipeline	San José AWPF	Gibraltar Reservoir	42	--	20,722	--	$47,700	$34
Pump Station	San José AWPF	Gibraltar Reservoir	--	--	--	--	$3,000	$240
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
Total:							$455,800	$14,470
TWA-2 - Option Summary								
AWPF	Former LATP	--	--	7	--	6,821	$108,000	$4,100
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Purified Pipeline	Palo Alto AWPF	Bifurcation	20	--	7,064	--	$8,100	$12
Purified Pipeline	Bifurcation	Palo Alto TBD	12	--	11,259	--	$7,300	$19
Purified Pipeline	Bifurcation	Miramonte Reservoir	20	--	26,506	--	$29,000	$44
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Palo Alto AWPF	Miramonte Reservoir	--	--	--	--	$6,100	$488
ROCM - Blend at existing outfall			--	--	--	--	$13,900	$170
Total:							$206,220	$5,212
TWA-3A - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Existing SU RW Pipeline	24	--	3,950	--	$5,100	$7

Project Element	**Location or Start Point**	**End Point**	**Diameter (in)**	**Flow Capacity (MGD)**	**Length (LF)**	**Long-Term Yield (AFY)**	**Total Capital Cost ($1,000s)**	**Annual O&M ($1,000s)**
Purified Pipeline	Wolfe Rd. Pipeline	Serra Tanks	20	--	9,004	--	$11,700	$15
Purified Pipeline	Tie-in allowance (10%)	--	--	--	--	--	$1,680	--
Pump Station	Sunnyvale AWPF	Serra Tanks	--	--	--	--	$4,100	$168
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$162,280	$4,560
TWA-3A Alt - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Existing SU RW Pipeline	24	--	3,950	--	$5,100	$7
Purified Pipeline	Existing SU RW Pipeline	San Lucar Pump Station	24		15,619		$20,500	$26
Purified Pipeline	Wolfe Rd. Pipeline	Serra Tanks	24	--	9,004	--	$11,700	$15
Purified Pipeline	Tie-in allowance (10%)	--	--	--	--	--	$3,730	--
Pump Station	Sunnyvale AWPF	Serra Tanks	--	--	--	--	$4,100	$168
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$184,830	$4,586
TWA-3B - Option Summary								
AWPF	Sunnyvale WPCP	--	--	7	--	6,821	$119,000	$4,100
Purified Pipeline	Sunnyvale AWPF	Miramonte Reservoir	24	--	53,211	--	$69,200	$87
Pump Station	Sunnyvale AWPF	Miramonte Reservoir	--	--	--	--	$5,400	$432
ROCM - New shallow water outfall			--	--	--	--	$20,700	$270
						Total:	$214,300	$4,889
TWA-4 - Option Summary								
AWPF	Morgan Hill	--	--	1.25	--	1,218	$50,000	$2,000
Effluent Pipeline	Morgan Hill Sanitary Sewer	Morgan Hill AWPF	12	--	3,092	--	$2,000	$6
Purified Pipeline	Morgan Hill AWPF	Morgan Hill Potable System	12	--	3,092	--	$2,000	$6
Pump Station	Morgan Hill Sanitary Sewer	Morgan Hill AWPF	--	--	--	--	$100	$8
Pump Station	Morgan Hill AWPF	Morgan Hill Potable System					$100	$8
ROCM - Evaporation Ponds			--	--	--	--	$22,550	$240
						Total:	$76,750	$2,268
SWA-5 - Option Summary								

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
AWPF	SCRWA	--	--	3	--	2,923	$70,000	$2,100
Purified Pipeline	SCRWA AWPF	Coyote Reservoir	16	--	55,660	--	$49,000	$91
Pump Station	SCRWA AWPF	Coyote Reservoir	--	--	--	--	$6,400	$512
ROCM - Evaporation Ponds			--	--	--	--	$45,100	$480
						Total:	$170,500	$3,183
TWA-6A - Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63
Purified Pipeline	Palo Alto AWPF	West Pipeline Extension	42		24,544		$62,000	$40
Purified Pipeline	West Pipeline Extension	--	Various	--	28,851	--	$310,000	$48
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$353
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$12,700	$1,016
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$896,040	$16,194
TWA-6A Alt - Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63
Purified Pipeline	Palo Alto AWPF	West Pipeline Extension	42		24,544		$62,000	$40
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$12,700	$1,016
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$586,040	$16,147
TWA-6B Option Summary								
AWPF	Former LATP	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	Palo Alto WQCP	Palo Alto AWPF	36	--	15,150	--	$29,400	$25
Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36		38,820		$74,100	$63

Project Element	Location or Start Point	End Point	Diameter (in)	Flow Capacity (MGD)	Length (LF)	Long-Term Yield (AFY)	Total Capital Cost ($1,000s)	Annual O&M ($1,000s)
Purified Pipeline	Palo Alto AWPF	Existing West Pipeline	42		52,844		$120,400	$87
Pump Station	Palo Alto WQCP	Palo Alto AWPF	--	--	--	--	$4,420	$354
Pump Station	Sunnyvale AWPF	Palo Alto AWPF	--	--	--	--	$4,420	$501
Pump Station	Palo Alto AWPF	West Pipeline Extension					$26,000	$2,080
ROCM - Blend at existing outfall			--	--	--	--	$29,000	$348
						Total:	$657,740	$17,258
TWA-7A - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Northside Storage Tanks	24	--	23,810	--	$31,000	$39
Purified Pipeline	San José AWPF	Piedmont Valve Yard	40	--	43,037	--	$93,400	$71
Pump Station	San José AWPF	Northside Storage Tanks	--	--	--	--	$700	$56
Pump Station	San José AWPF	Piedmont Valve Yard	--	--	--	--	$15,200	$1,216
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$545,400	$15,547
TWA-7B - Option Summary								
AWPF	San José	--	--	24	--	23,400	$370,000	$13,800
Effluent Pipeline	San José/Santa Clara RWF	San José AWPF	60	--	2,000	--	$6,400	$3
Purified Pipeline	San José AWPF	Piedmont Valve Yard	42	--	43,037	--	$98,100	$71
Pump Station	San José AWPF	Piedmont Valve Yard	--	--	--	--	$16,800	$1,344
ROCM - Discharge beyond RWF Weir			--	--	--	--	$28,700	$362
						Total:	$520,000	$15,580

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Appendix A-9: Evaluation of Onsite Reuse in Santa Clara County

Brown AND Caldwell

75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

Technical Memorandum

Prepared for: Santa Clara Valley Water District

Project Title: Countywide Water Reuse Master Plan

Project no.: 4821 (District); 151772 (BC Internal)

Contract no.: A4120A

Appendix A-9

Subject: Evaluation of Onsite Reuse in Santa Clara County

Date: September 16, 2020 (reissued April 19, 2021)

To: Miguel Silva, District Project Manager

From: Jenny Gain, P.E., BC Team Project Manager

Copy to: David Tucker, District Assistant Project Manager

Prepared by: Joe Burg, P.E., Brown and Caldwell

Curtis Lam, P.E., HydroScience Engineers

Brian Pecson, Ph.D., P.E., Trussell Technologies

Reviewed by: Wendy Broley, P.E., Brown and Caldwell

Rosey Jencks, Brown and Caldwell

Limitations: This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and BC dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Table of Contents

Section 1: Purpose 1
Section 2: Onsite Reuse in and around Santa Clara County 1
2.1 Existing and Planned Onsite Reuse in Santa Clara County 2
    2.1.1 Mountain View 2
    2.1.2 Palo Alto 2
    2.1.3 San José 3
    2.1.4 Sunnyvale 3
2.2 Facebook’s Onsite Reuse Project in San Mateo County 3
2.3 Planning and Regulation in Santa Clara County 3
Section 3: Regulatory context 4
3.1 National efforts 4
3.2 Statewide efforts 4
3.3 Local efforts 5
3.4 Future development of local policies, guidelines, and programs 6
    3.4.1 Implications of State Bill 966 6
    3.4.2 Potential Challenges for Onsite Reuse Programs 6
Section 4: Potential Implications for Wastewater Utilities 7
4.1 Existing Centralized Infrastructure 7
4.2 Challenges 8
4.3 Opportunities 9
Section 5: Summary and Recommendations 10
5.1 Recommendations 11
References 12

List of Tables

Table 1. Partner Agency Staff Interviewed 1
Table 2. Challenges with Onsite Reuse and Available Resources 7
Table 3. Treatment Facility Flows and Recycled Water Production 8
Table 4. Challenges and Opportunities Arising from Increased Onsite Reuse 11

List of Abbreviations

ADWF	Average Dry Weather Flow
BC	Brown and Caldwell
CII	commercial, industrial, institutional
CUWA	California Urban Water Agencies
EPA	U.S. Environmental Protection Agency
gpd	gallon(s) per day
LEED	Leadership in Energy and Environmental Design
Master Plan	Countywide Water Reuse Master Plan
mgd	millions of gallons per day
NBRC	National Blue-Ribbon Commission for Onsite Non-Potable Water Systems
NSF	National Science Foundation
Onsite reuse system	onsite non-potable water reuse systems
PA/MV RWQCP	Palo Alto/Mountain View Regional Water Quality Control Plant
SB 966	Senate Bill 966
State Board	California State Water Resources Control Board
TM	technical memorandum
USGBC	US Green Building Council
Valley Water	Santa Clara Valley Water District

Section 1: Purpose

This technical memorandum (TM) supports the Countywide Water Reuse Master Plan (CoRe Plan) and provides a summary of the current state of existing and planned onsite non-potable water reuse systems (onsite reuse systems), also referred to as decentralized reuse systems, in Santa Clara County. Onsite reuse refers to wastewater treatment for reuse at the building- or development-scale. Wastewater is collected from the building or neighborhood and treated onsite. The resulting recycled water can then be used onsite for irrigation, toilet-flushing, cooling tower water, or other non-potable uses.

This TM also describes the regulatory context for onsite reuse projects and programs and considers the potential opportunities and challenges for water and wastewater utilities related to increasing implementation of onsite reuse projects, including the potential implications for existing infrastructure.

Section 2: Onsite Reuse in and around Santa Clara County

Although the number of existing and planned onsite reuse systems in Santa Clara County is relatively small, local governments face challenges in planning for and regulating the projects.

The project team interviewed staff from four of CoRe Plan project Partner Agencies: San José, Palo Alto, Mountain View, and Sunnyvale regarding existing and planned onsite reuse systems within their service areas and the planning and regulation of onsite reuse to date. Morgan Hill and Gilroy staff were not interviewed due to limitations caused by the COVID-19 pandemic. Table 1 identifies the staff interviewed at each City.

Table 1. Partner Agency Staff Interviewed

City	Department/Division	Staff Member(s)
Mountain View	Public Works Department-Utilities	Ankit Sharma Salman Husaini
Palo Alto	Department of Public Works	Karin North Diego Martinez Garcia
San José	Water Resources Division	Pedro Hernandez
Sunnyvale	Environmental Service Department	Mansour Nasser Bryan Berdeen

Section 2.1 describes the known planned onsite reuse projects in the Santa Clara County based on these interviews and desktop research. Section 2.2 briefly describes the Facebook onsite reuse system located in neighboring San Mateo County. Section 2.3 summarizes staff perspectives on the future of onsite reuse in the Santa Clara County and their regulation.

2.1 Existing and Planned Onsite Reuse in Santa Clara County

Of the four cities interviewed, only Mountain View has planned and permitted projects, one of which is under construction. In other cities, staff were not aware of any proposed developments with onsite reuse in their municipalities, but discussed the likelihood of future projects, how they might go about permitting proposed projects, and what their concerns are regarding impacts of potential future projects.

2.1.1 Mountain View

Mountain View City staff believe that internet and technology companies implementing onsite reuse projects are motivated by a desire to achieve Leadership in Energy and Environmental Design (LEED) certification, and, in the case of stormwater projects, facilitate compliance with Municipal Regional Stormwater NPDES Permit provision C.3. There appear to be other drivers related to enhancing their brand reputation to improve employee recruitment and retention, and improve water supply resilience and independence in the face of droughts, climate change, and associated rising water rates (Pacific Institute, 2021). Mountain View has three onsite reuse projects under development by tech companies:

- Microsoft's Silicon Valley Campus (blackwater reuse, along with rain and stormwater capture and reuse, approximately ~20,000 gallons per day [gpd])
- Google Charleston East (rain and stormwater capture and reuse),
- Google Landings (rain and stormwater capture and reuse)

A fourth onsite reuse system, Google Bay View, is located very close to Mountain View on Federal land at Moffett Field. It will include a blackwater reuse system, but Mountain View staff are not involved with permitting due to Federal jurisdiction over the land. Mountain View staff have struggled to clarify which government entity (state, county, or city) has jurisdiction over permitting onsite reuse projects. Rain and stormwater reuse projects are typically under city permitting jurisdiction, including potential Santa Clara County Department of Public Health involvement for in-building reuse applications. However, a project that blends rain and/or stormwater with municipal Title-22 regulated recycled water triggers state involvement and standards. Due to the lack of expertise on permitting water treatment systems, City staff welcomed state involvement. Further discussion of regulatory oversight is included in Sections 2.2

Mountain View staff had concerns that onsite reuse projects would (1) cause impacts to wastewater collection and treatment by concentrating flow in the centralized sewer system, and (2) be unreliable in the event that operational challenges occur. The city addressed these concerns for the Microsoft project by (1) asking the company to haul away solids generated by the plant rather than discharging them to the sewer, and (2) having the company agree to pay the full sewer capacity charge that they would have paid without the system.

Mountain View staff were somewhat concerned that onsite systems will reduce demand for municipal recycled water, and felt that ideally, onsite reuse projects would be developed in areas of the city that do not have access to municipal recycled water. However, the city does not plan on prohibiting or disincentivizing onsite projects in areas that have municipal recycled water because they don't want to stifle innovation in the water reuse space.

Mountain View staff were not able to provide cost information about current onsite reuse projects, although this is an important metric for understanding the potential for onsite reuse to expand.

2.1.2 Palo Alto

Palo Alto does not currently have any proposed projects under city review. There have been some discussions with Stanford University's Codiga Resource Recovery Center, a research facility testing wastewater treatment and reuse technologies started in 2016, regarding its use as a satellite treatment facility in the future.

2.1.3 San José

The City of San José does not currently have any proposed projects under city review. However, the City and San Jose Water Company are in discussions with Google regarding concepts for onsite blackwater treatment and non-potable reuse as part of the Diridon Station Area Plan.

2.1.4 Sunnyvale

Sunnyvale is not aware of any planned onsite reuse projects, nor does it have any under City review. The City has not yet established a permitting pathway or process for onsite reuse projects.

2.2 Facebook's Onsite Reuse Project in San Mateo County

The largest onsite reuse system near Santa Clara County is likely the 90,000 gallon per day system at Facebook's headquarters in Menlo Park. The Facebook system's permitting process required the project team to initiate and coordinate interactions between many stakeholders, including the City of Menlo Park, San Mateo County Health Department, San Francisco Bay Regional Water Quality Control Board, State Water Resources Control Board's Division of Drinking Water, Silicon Valley Clean Water (producer of treated wastewater), and West Bay Sanitary District (collection system agency). In many cases, these agencies had not previously coordinated on projects, leading to confusion regarding what the requirements for the project would be and who had jurisdiction to lead the different permitting roles. In interviews, city staff in Santa Clara County described similar challenges to those encountered in the planning, regulation, and coordination of the Facebook project.

2.3 Planning and Regulation in Santa Clara County

Based on interview responses, planning and regulation of onsite reuse in Santa Clara County has been difficult for city staff for several reasons, including:

- The Santa Clara County has been slow to engage on regulation and planning of onsite re-use systems due to limited resources and staff time.
- Regulatory and jurisdictional oversight is not clear for rain and stormwater capture and reuse projects. In Mountain View, the use of municipal recycled water for make-up or blending water is the primary trigger for state regulation under California Water Code Title 22. If municipal recycled water is not blended in, stormwater and rainwater capture and reuse projects would need to be permitted at the local and Santa Clara County levels, and staff may need additional guidance.
- The regulating authority is clearer for blackwater projects. The California State Water Resources Control Board (State Board) agreed to permit the Microsoft blackwater facility that is currently under construction.
- The City of Mountain View requires all commercial buildings greater than 25,000 square feet to be dual plumbed, which provides opportunities in the future for more building-scale non-potable reuse systems. However, once built, the retrofit of these properties to recycled water remains challenging and requires compliance with Title 22. This includes completion, approval, and implementation of a Dual Plumbing Engineering Report; and ongoing cross connection testing and compliance with monitoring requirements. Palo Alto also requires dual plumbing for any project with a total building square footage greater than 100,000 square feet, but recent tenant improvements of commercial buildings stayed below the threshold to date.

Many of the issues described by city staff have also been encountered in other parts of the country. Section 3 provides a brief description of the wider regulatory context for onsite reuse projects.

Section 3: Regulatory context

Interviews with city staff in Santa Clara County indicate that regulatory complexity was a major challenge for both developers and government staff in permitting onsite reuse projects. One solution implemented by local governments elsewhere has been to implement onsite reuse programs, which establish pathways for developers to submit projects for approval. Typically, multiple agencies are involved in administering an onsite reuse program. Program administrators may include water and wastewater agencies, building inspectors, public health regulators, and others. This section provides an overview of the national, state, and local efforts currently underway to provide additional clarity on best practices for planning for, implementing, and regulating onsite reuse projects and programs.

3.1 National efforts

At this time, there is no national regulatory guidance from the federal government on onsite reuse. The lack of national guidance has resulted in a wide range of implementation approaches throughout the country. However, several organizations provide guidance or recommendations for onsite reuse systems at the national or international level.

- **U.S. Environmental Protection Agency (US EPA).** While the US EPA has supported various efforts to develop recommendations for onsite reuse, it has not indicated that it will develop regulations for a nationwide program.
- **National Science Foundation (NSF) International.** NSF/American National Standards Institute have released two standards: 350,“Onsite Residential and Commercial Water Reuse Treatment Systems” and 350-1, “Onsite Residential and Commercial Graywater Treatment Systems for Subsurface Discharge.”
- **US Green Building Council (USGBC).** LEED certification, overseen by the USGBS, is one of the primary drivers for building owners to implement onsite reuse systems. LEED scoring provides credits for onsite reuse as a water efficiency strategy. Based on the groundwork developed by California Urban Water Agencies (CUWA) in its 2019 report on reuse options, USGBC is currently working with WateReuse to refine the credits and incentivize developers to coordinate with local water and wastewater utilities when implementing onsite reuse projects.
- **National Blue-Ribbon Commission for Onsite Non-Potable Water Systems (NBRC).** In an effort to facilitate more consistent implementation, the NBRC has created numerous documents to guide the development of onsite reuse projects and programs nationwide. The NBRC is comprised of advocates for onsite systems from various backgrounds (agencies, regulators, researchers) with the common goal of supporting local, statewide, and national initiatives to promote the growth of onsite reuse.

3.2 Statewide efforts

Although some local jurisdictions have developed programs to administer onsite reuse in California, many projects have been pursued in the absence of a program. This requires system owners and local regulators to navigate a complex system of existing rules and regulations from various entities (e.g., building codes, plumbing codes, State Board, etc.). To streamline this process and provide for more consistent onsite reuse programs and projects statewide, Senate Bill 966 (SB 966) was approved in September 2018, which mandates the development of statewide regulations by December 2022.

Per SB 966, the State Board must adopt risk-based water quality standards and requirements for onsite reuse. Unlike the existing governance structures for municipal drinking and recycled water, SB 966 states that local jurisdictions (such as cities or counties) permitting onsite reuse systems may establish their own program and be responsible for overseeing the program to ensure the protection of public health. A local jurisdiction does not need to be the same entity that is providing water or sewer service to the community, though the water and sewer service providers must be given an opportunity to demonstrate that onsite reuse would not have a significant adverse impact on their operations, receiving waters, or existing or planned centralized reuse projects before the local onsite reuse program is formed.

Another important aspect of SB 966 is that it requires all onsite reuse projects to be implemented under the auspices of an established onsite reuse program. This provision intends to enhance the safety and consistency of onsite reuse projects by establishing clear regulatory oversight. For ongoing onsite reuse projects or for those that will be implemented prior to the effective date of the State Board's regulations, the system owners will have two years to comply with the new risk-based treatment standards (or up to five years for special circumstances). In requiring all onsite reuse projects be implemented under an onsite reuse program, this provision will also likely drive the development of onsite reuse programs in local jurisdictions across the state.

3.3 Local efforts

The only municipality in the Bay Area that has a fully developed onsite reuse program is San Francisco. San Francisco's experience largely influenced the structure of SB 966 and the city's program is one of the few existing programs in California that would comply with the requirements of the law. Perspectives on the program may be most useful for agencies such as Santa Clara Valley Water District (Valley Water) or Partner Agencies that may become stakeholders involved in a program and/or its administration.

The City and County of San Francisco developed their Onsite Water Reuse for Commercial, Multi-Family, and Mixed-Use Development Ordinance in 2012. This Non-Potable Water Ordinance modified the San Francisco Health Code to allow for the collection, treatment, and use of alternate source waters for non-potable applications. The addition of Article 12C to the Health Code requires new development projects greater than 250,000 square feet to install and operate an onsite reuse system to treat and reuse graywater, rainwater, and foundation drainage for toilet and urinal flushing and irrigation. The treatment requirements include risk-based targets for pathogen control that were developed by a national Expert Panel in 2017 (Sharvelle et al, 2017). The State Board's future treatment requirements will include similar risk-based values.

San Francisco's onsite water reuse program organizes multiple city agencies under a single structure, including San Francisco Public Utilities Commission, the Department of Public Health, the Department of Building Inspection, and the Department of Public Works. Collectively, these agencies administer the program and are responsible for the approval and permitting process. In addition to the coordination between the agencies administering the program, there are also resources to help project applicants navigate the permitting and approval process. One of these is an eight-step guidebook for implementing systems that defines the roles and responsibilities for each agency and describes how a project will interact with the various agencies through a sequence of submittals and required actions (SFPUC, 2017). This and other resources help streamline project development by clearly laying out the steps for implementation.

3.4 Future development of local policies, guidelines, and programs

In Santa Clara County, interest in onsite reuse is increasing, though local jurisdictions have not yet organized to the same degree as San Francisco. The experience of Facebook's onsite reuse project in San Mateo County, described in Section 2.2, highlights the challenges associated with a less formal program structure. This section describes the impact SB 966 may have on efforts to develop policies and guidelines in Santa Clara County, as well as potential challenges in developing onsite reuse programs.

3.4.1 Implications of State Bill 966

SB 966 will impact existing and planned onsite reuse projects in Santa Clara County by requiring them to adapt to the new standards, though it should also lead to more streamlined implementation when the local jurisdictions develop their own onsite reuse programs. Due to the requirements of SB 966, future onsite reuse efforts in Santa Clara County will require the coordination and participation of multiple stakeholders including Valley Water and the wastewater agencies. Under the law, water and wastewater providers will need to either consent to an onsite reuse program or demonstrate how such a program would detrimentally impact:

1. Operations, maintenance, or management of collection or treatment systems,
2. Existing or planned centralized recycled water or potable reuse projects due to reduced flows, or
3. The provider's receiving waters.

The jurisdiction overseeing the program would have to either avoid or mitigate impacts in the three categories above before adopting an onsite reuse ordinance. Valley Water evaluated the availability of wastewater flows in the CoRe Plan and other past studies. This information—along with findings from its Reverse Osmosis Concentrate Management study—should be used to evaluate the impact of onsite reuse on current and future projects.

If the local jurisdiction decides to pursue onsite reuse, a local program that is compliant with SB 966 must be formed. To form the local program, the jurisdiction would identify participating agencies and stakeholders and develop a program structure. SB 966 prescribes that the state develop uniform standards for adoption by the local program, eliminating the need for the local program agencies to develop requirements for aspects of onsite reuse systems such as treatment, monitoring, and reporting.

As a local program is developed, it is recommended that available resources be consulted to serve as templates. It is also recommended that future program administrators leverage the experience and lessons learned from existing projects in Santa Clara County and the surrounding area. Both local program administrators and stakeholders pursuing onsite reuse projects should seek to build system owner, designer, and operator capacity and knowledge (Pecson and Post, 2020).

3.4.2 Potential Challenges for Onsite Reuse Programs

This section provides an overview of potential issues that arise when creating an onsite reuse program. Table 2 at the end of the section lists resources to help agencies address these issues.

- **Impacts to municipal systems.** Onsite reuse can have unintended impacts on municipal systems. A successful onsite reuse program should address and mitigate these impacts by bringing together all the relevant stakeholders. These impacts are described in greater detail in Section 4.2.
- **Lack of consistent standards.** The lack of standards for treatment, monitoring, and operations have been cited as impediments to implementation of onsite projects. Ad hoc regulatory requirements will likely lead to inconsistency across cities and regions within the state. As described above, there is currently a lack of regulatory guidance and standards at the national, state, and local level. However, SB

966 will require uniform standards for all onsite reuse projects in California, including requirements for water quality, treatment, monitoring, reporting, cross-connection control, and more.

- **Lack of existing program administration.** Well-organized program administration is critical to streamline the permitting process and promote additional projects. The lack of a clear approval and permitting process is likely to be a significant obstacle for many projects. Resources with recommendations for program structure have been developed by the NBRC and other agencies.
- **Lack of stakeholder experience.** Onsite reuse requires the participation of multiple stakeholders—including program administrators, regulators, design engineers, operators, and system owners—that may have varying degrees of knowledge and experience in this topic. Successful implementation of onsite reuse depends on stakeholders having the necessary expertise to ensure the safety and reliability of onsite reuse. Resources to promote capacity building for stakeholders include Water Research Foundation #4909, a guidance manual and training modules targeting program administrators, regulators, design engineers, operations, and system owners.
- **Identifying operational responsibility.** Because the utility/municipality isn't in charge of operation and management of onsite reuse systems, it is important that a responsible management entity be identified that will take responsibility for regulatory compliance.

Table 2. Challenges with Onsite Reuse and Available Resources

Challenge	Resources
Impact on municipal systems	• Making the Utility Case for Onsite Non-Potable Water System (NBRC, 2018) • Guiding Regional Reuse Options: A Distributed Systems Approach (CUWA, 2019)
Lack of consistent standards	• Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems (Sharvelle, S., et al, 2017) • SB 966 (SB 966, 2018) • A Guidebook for Developing and Implementing Regulations for Onsite Non-potable Water Systems (NBRC, 2017) • Model State Regulation for Onsite Non-potable Water Programs (NBRC, 2017)
Lack of existing program administration	• Model Local Ordinance for Onsite Non-Potable Water Programs (NBRC, 2017) • Model Program Rules for Onsite Non-potable Water Systems (NBRC, 2017) • Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems (NBRC, 2014)
Lack of stakeholder experience	• Guidance Manual and Training Materials for Onsite Nonpotable Water Systems (Pecson, B., Post, B., et al, 2020)

Section 4: Potential Implications for Wastewater Utilities

This section discusses the challenges and opportunities that onsite reuse projects present for water and wastewater utilities. To provide context for considering impacts to utility systems from onsite reuse, this section begins with a high-level overview of the existing centralized infrastructure that serves Santa Clara County communities.

4.1 Existing Centralized Infrastructure

There are four wastewater treatment plants that collect and treat sewage in Santa Clara County. Details about the current average dry weather flow (ADWF), peak wet weather flow (PWWF), use of effluent, and planned recycled water distribution systems are presented in Appendix E-1, Baseline Analysis TM. Table 3 presents the average inflows into each plant, the design flows for each facility, and the current recycled water production capacity of each plant.

Table 3. Treatment Facility Flows and Recycled Water Production

Facility	Average Inflow (mgd)[a]	Design ADWF (mgd)	Design PWWF (mgd)	Recycled Water Production Capacity (mgd)
PA/MV RWQCP	19.9	39.0	80.0	4.5
Sunnyvale Water Pollution Contol Plan	12.3	29.5	40.0	4.0
San José/Santa Clara Regional Wastewater Facility [b]	99.0	167.0	271.0	38.0
South County Regional Wastewater Authority wastewater treatment plant	6.5	8.5	N/A	9.0
Silicon Valley Advanced Water Purification Center [c]	5.7	N/A	N/A	8.0

a. Average inflows are from 2015-2017.

b. San José/Santa Clara RWF recycled water production is currently limited by filtration capacity.

c. SVAWPC produces purified water.

mgd = million gallons per day

Each of these treatment plants receives wastewater from collection systems maintained by one or more entities. Collection systems are typically sized to be able to convey 1) design flows associated with the land use, 2) groundwater infiltration, and 3) rainfall-dependent inflow and infiltration.

4.2 Challenges

Onsite reuse projects have the potential to create challenges for water and wastewater utility systems and their operation, particularly in aggregate. Many of these challenges are due to that fact that, by treating and reusing wastewater at the building scale, onsite reuse projects have the potential to reduce the flow of wastewater that enters the collection system. While some onsite systems truck away solids from the treatment process, others may discharge them into the local collection system, resulting in more concentrated waste streams. For example, if an onsite reuse system treats 200,000 gpd of sewage for reuse but discharges 20,000 gpd of the waste solids resulting from the treatment into the collection system, that discharge would be approximately 10 times the concentration of the original wastewater flow.

The magnitude of these challenges varies depending on the utility system and details of the project in question. For onsite reuse projects and programs to succeed, the challenges described below should be addressed collaboratively by project stakeholders.

- Reduced flow to sewers. In the collection system, reduced flows and concentrated waste streams have the potential to reduce velocities in collection systems and reduce the transport of solids and debris, which could lead to odor and corrosion issues. In these areas, periodic flushing or the removal and disposal of solids may be required to address these issues. In San Francisco, the onsite reuse program has used hydraulic modeling to understand the impacts of reduced flows in the collection system downstream of the project before its implementation, allowing corrective measures to be taken. The reduced flows from onsite reuse projects can exacerbate existing issues with declining flows in collection systems due to water efficiency measures.

- **Reduced flow to wastewater treatment plants.** Higher strength wastewater may also pose a challenge to wastewater treatment plants if they are not designed or operated to account for higher organic and solids content. Whether this change in influent concentration has an impact on treatment plant operations would be a subject for process engineers at each facility to evaluate based on testing and monitoring. In Santa Clara County, existing onsite reuse systems have relatively small capacities compared to the downstream treatment. For example, the Microsoft project described in Section 2.2 has a daily capacity of approximately 20,000 gpd (Gallagher and Saikkonen 2018). The Microsoft project is tributary to the Palo Alto/Mountain View Regional Water Quality Control Plant (PA/MV RWQCP). The PA/MV RWQCP has an ADWF of 19.9 mgd and a Design PWWF of 80 mgd, which is approximately 1,000 times the capacity of the Microsoft system. However, while one onsite reuse system may not be a significant portion of the flow to a downstream plant, the combination of multiple onsite reuse facilities could impact the influent flows and water quality for local treatment plants.
- **Increases in salinity.** Onsite reuse projects that incorporate reverse osmosis technology also produce concentrate that can raise the overall salinity of the wastewater if discharged into the sanitary sewer. This increased salinity may negatively impact other municipal goals by changing the quality of the effluent, recycled water, or purified water.
- **Planning for non-operation and stranded assets.** Issues could arise if the infrastructure serving a development with an onsite reuse system is sized without consideration of the flows of water and wastewater that are managed by the onsite system. In this case, the infrastructure would be undersized should the system stop operating. In most cases, this means that a parcel with an onsite reuse system should have the same size sewer connections as a similar parcel without an onsite reuse system. This allows the city to maintain sewer capacity for the parcel in case the onsite system is temporarily or permanently placed out of service. For example, Stanford University constructed an onsite reuse system during the 2000s to collect and treat blowdown from the Central Energy Facility for reuse as recycled water. During the next decade, the University decided to remove this facility and the blowdown was instead discharged to the sewer system. If sewer capacity is reserved for onsite reuse project sites, these projects may not provide cost savings for surrounding sewer systems and centralized treatment infrastructure.
- **Sanitary Sewer Service and Use Charges.** Each entity collecting and/or treating wastewater in Santa Clara County has its own sanitary sewer service and use charges. These charges can vary based on location, type of land use, the strength of the sewage, and the quality of the sewage. Onsite reuse can raise concerns about revenue impacts due to reduced potable water consumption and wastewater flows. In areas where onsite reuse systems are already planned or in operation, utilities are working with stakeholders to resolve billing questions, including considering connection fees and charges based on wastewater flows and concentration.
- **Reduced use of municipal recycled water.** In areas where utilities have invested in the development of centralized recycled water treatment and distribution, onsite reuse systems can cause concern because they reduce demand for recycled water. If onsite reuse systems are implemented widely in a sewershed, diversion of flows by these systems may also impact the amount of flow available for municipal scale recycled or purified water programs.

4.3 Opportunities

The implementation of onsite reuse projects within a utility's service area can also create opportunities for the utility. Diversifying and stretching existing water supplies through reuse of any kind can increase water supply reliability. This section provides a list of potential opportunities related to onsite reuse for water and wastewater providers. However, the degree to which these benefits are realized depends on multiple factors, including the configuration of the existing water and wastewater infrastructure, the type of onsite reuse, and the scale of the project.

- **Provide Additional Recycled Water Supply Options** - Although municipal-scale non-potable reuse is becoming more widespread, there are often areas of a community that do not have access to the recycled water distribution system. This can be caused by a variety of reasons including a) limited funds for infrastructure expansion, b) the infeasibility of installing centralized recycled water infrastructure in high-density urban areas, and c) the geographic separation of new developments from recycled water systems. If a building owner is interested in using recycled water, the development of an onsite reuse program can provide the opportunity for recycled water projects in areas that otherwise may not have access.
- **Promote Public Awareness and Adoption** - Onsite reuse projects bring the concept of recycling water for a new use directly into the lives of community residents. Residents or tenants in buildings with onsite reuse systems can experience the benefits of recycling water first-hand and gain trust in its safety. By promoting awareness in the community, it may further foster understanding and support for municipal-scale projects for non-potable and potable reuse. This benefit, however, hinges on maintaining a successful and trustworthy onsite reuse program. This experience can also promote the concept of the “right water for the right use,” i.e., the use of water that has been appropriately treated for its end use.
- **Reduce Demands on Infrastructure and Defer Capital Costs** – In some cases, treating wastewater onsite can help reduce demands on existing infrastructure by reducing peak water demands and sewer flows (NBRC, 2018). However, in most cases onsite reuse systems must have traditional infrastructure connections sized to provide for the building or neighborhood in case the onsite system is taken out of operation. These redundant connections mean that opportunities for cost savings in capital costs are limited. Water and wastewater agencies have the potential to save energy, resources, and operational costs through the addition of decentralized systems (NBRC, 2018, CUWA, 2019).
- **Sea Level Rise and Wastewater Treatment Plants** - Onsite reuse can be used to continue to provide water management and treatment services in locations where sea level rise and groundwater flooding jeopardize centralized systems for both wastewater treatment and non-potable supplies. Distributed systems could have the potential to allow providers to migrate services to locations less impacted by these hazards.
- **Reduce Environmental Impacts from Stormwater** - Onsite reuse projects can also be used to positively impact the environment. SB 966 allows for the capture and treatment of both rainwater and stormwater that would otherwise be discharged to surrounding water bodies or potentially flow into local wastewater treatment plants. This uncontrolled discharge of untreated water that often contains pathogens, nutrients, and organics can lead to detrimental impacts on the surrounding environment in addition to nuisance flooding during storm events. By diverting rain and stormwater, the onsite reuse project can enhance supplies while reducing contaminant loads to the environment (NBRC, 2018). However, the potential negative impact of reducing contributions to instream flows in local waterways must also be considered.

Section 5: Summary and Recommendations

Based on the current scale of onsite reuse implementation in the County and an assessment of the potential benefits, challenges, and implications of onsite reuse discussed above, Table 4 summarizes the potential opportunities and challenges for Valley Water and its Partner Agencies that would be presented by increased implementation of onsite reuse systems in Santa Clara County.

Table 4. Challenges and Opportunities Arising from Increased Onsite Reuse	
Opportunities	**Challenges**
Valley Water	
• Encourages innovation in smaller scale water reuse facility design, operation, maintenance, and governance • Promotes public awareness of and comfort with water reuse • May provide source of recycled water to projects and locations that are unlikely to connect to municipal recycled water	• Reduces demand for recycled water produced by Valley Water • Reduces wastewater flow available for centralized reuse
Partner Agencies	
• Develop treatment capacity at elevations unlikely to be impacted by sea level rise • Promote public awareness of and comfort with water use	• Potential to contribute concentrated flows and solids to collection system if not disposed of in another manner • Reduces demand for recycled water in areas where investments in municipal infrastructure have already been made • Reduces wastewater flow available for reuse

5.1 Recommendations

Implementation of onsite reuse in Santa Clara County is just beginning, but the County has the potential to serve as a test case for how onsite reuse can dovetail with municipal and regional infrastructure systems. In order to inform future policy making, Valley Water should continue to study current and future onsite reuse projects in Santa Clara County. Next steps for more detailed evaluation and future study may include:

1. Quantify the potential range of onsite reuse that could occur within Valley Water's service area by considering multiple scenarios for commercial, industrial, institutional (CII) development anticipated between now and 2035 or other planning horizon, as applicable.
2. Identify attributes of projected new development locations as they relate to onsite reuse:
    a. Existing or planned sewer connection capable of handling the waste should the onsite system go down or cease use in the future?
    b. Existing or planned access to municipal recycled water?
    c. Areas where existing water or wastewater systems are reaching capacity?
    d. Locations in sewersheds that have centralized reuse goals to meet?
    e. Presence of potential sources of non-potable water, such as foundation drainage water.
3. Identify the range of wastewater flows that will be:
    a. Produced if planned CII development (and redevelopment) is served by centralized infrastructure; and
    b. Diverted if onsite reuse comes online.
4. Study the feasibility of a mechanism for companies interested in advancing water supply sustainability and innovation to contribute to district- or municipal-scale systems (e.g. expanding recycled water distribution, advanced water treatment, or scalping plants strategically integrated into the wastewater system) in lieu of developing their own onsite reuse system.
    a. Continue coordination with USGBC through WateReuse and CUWA to stay informed on whether equal LEED credits can be given for using onsite reuse as for contributing to a district-scale or municipal-scale system.
5. Study the role of onsite reuse in promoting resilience to extended droughts, sea level rise, and groundwater flooding.

6. Evaluate the impacts of onsite reuse implementation on equitable access to utility systems in the Santa Clara County.
7. If Valley Water and/or Partner Agencies choose to participate in an onsite water reuse program, develop applicable policies and guidelines using the resources identified in Section 3.4.2.

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Appendix A-10: Flexible Implementation of Potable Reuse, via San-José AWPF

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Technical Memorandum

75 E Santa Clara Street, Suite 375
San José, CA 95113
T: 408.703.2535

Prepared for: Santa Clara Valley Water District (Valley Water)

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Appendix A-10

Subject: Flexible Implementation of Potable Reuse – via San José AWPF

Date: May 5, 2021

To: David Tucker, Valley Water, Project Manager

From: Jenny Gain, P.E., Brown and Caldwell, Consultant Team Project Manager

Prepared by: Rene Guillen, P.E., Brown and Caldwell
California License C83467

Curtis Lam, P.E., HydroScience Engineers
California License C59049

Reviewed by: Adam Zacheis, P.E., Brown and Caldwell
California License C65696

Melanie Holmer, P.E., Brown and Caldwell
California License C63236

Limitations:

This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell (BC) dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Table of Contents

Section 1: Introduction 2

Section 2: Project Characteristics 4

2.1 Treatment Capacity Assumptions 5

2.2 Treatment Level 6

Section 3: San José Flex Scenarios 7

3.1 GWR Flex 7

3.2 RWA Flex 13

3.3 TWA Flex 18

3.4 Flex Scenario Cost Comparison 23

Section 4: Pipeline Sizing Cost Evaluation 25

Section 5: Considerations for Next Steps 28

Attachment A: TWA Demand Assessment A-1

Attachment B: San José Flex Scenario Cost Estimates B-1

Attachment C: San José Pipeline Sizing Cost Analysis C-1

List of Figures

Figure 1-1. Flexible implementation involves advancing a near-term GWR project designed and constructed to enable potential future expansion 3

Figure 2-1. Assumed source water flow rates and production capacities for flex implementation 5

Figure 2-2. AWPF process flow diagram for the near-term project and GWR Flex 6

Figure 2-3. AWPF process flow diagram for RWA Flex 6

Figure 2-4. AWPF process flow diagram for TWA Flex 7

Figure 3-1. Site layout for San José GWR Flex 9

Figure 3-2. San José AWPF preferred project site location and vicinity 11

Figure 3-3. Map of San José near-term project and GWR Flex facilities and delivery point (LGRP) 12

Figure 3-4. Site layout for San José RWA Flex 15

Figure 3-5. Map of San José RWA Flex facilities and delivery points (LGRP and Rinconada WTP) 17

Figure 3-6. Map of San José TWA Flex facilities and delivery points (LGRP and potable distribution connections) 19

Figure 3-7. Site layout for San José TWA Flex 21

Figure 3-8. Estimated Capital Costs of San José Flexible Implementation Scenarios 24

Figure 3-9. Estimated O&M Costs of San José Flexible Implementation Scenarios 24

Figure 4-1. Facility locations, delivery points, and alignments for TWA Flex using pipelines tapered in diameter from the San José AWPF to LGRP 27

List of Tables

Table 3-1. San José GWR Flex Project Elements 8

Table 3-2. Estimated Costs for San José GWR Flex 13

Table 3-3. San José RWA Flex Project Elements 14

Table 3-4. Estimated Costs for San José RWA Flex........18

Table 3-5. San José TWA Flex Project Elements........20

Table 3-6. Estimated Costs for San José TWA Flex 23

Table 4-1. Estimated Conveyance Costs under Various Scenarios for Purified Water Pipeline Diameter from San José AWPF to LGRP........26

Table A-1. Potential TWA Deliveries along the San José GWR Alignment........A-3

Table B-1. Overview of Capital and Annual O&M Costs for San José Flex Scenarios B-3

Table B-2. Cost Estimate Details: San José AWPF for GWR Flex........B-4

Table B-3. Cost Estimate Details: San José AWPF for RWA Flex........B-11

Table B-4. Cost Estimate Details: San José AWPF for TWA Flex B-18

Table B-5. Cost Estimate Details: 36-inch Purified Water Pipeline from San José AWPF to LGRP B-25

Table B-6. Cost Estimate Details: 36-inch Purified Water Pipeline from LGRP to Rinconada WTP (*Rinconada Extension*)........B-26

Table B-7. Cost Estimate Details: 16-inch Purified Water Pipeline from GWR Alignment to San José Muni Nortech/Tasman........B-27

Table B-8. Cost Estimate Details: 12-inch Purified Water Pipeline from GWR Alignment to Santa Clara Northside B-28

Table B-9. Cost Estimate Details: 16-inch Purified Water Pipeline from GWR Alignment to SJ Water Campbell........B-29

Table B-10. Cost Estimate Details: 30-inch Purified Water Pipeline from GWR Alignment to Santa Clara Jenny Strand Park/Valley Water Treated Water PL B-30

Table B-11. Cost Estimate Details: Purified Water Booster Pump Station from LGRP to Rinconada WTP (RWA Flex)........B-31

Table B-12. Cost Estimate Details: Purified Water Pump Station (up to 10 mgd) from San José AWPF to LGRP (Near-Term GWR Project) B-33

Table B-13. Cost Estimate Details: Purified Water Pump Station (Flexible Expansion, up to 24 mgd) from San José AWPF to LGRP (GWR Flex) B-35

Table B-14. Life-cycle Unit Costs for San José 10 mgd Near-Term GWR Project B-37

Table C-1. Overview of Costs for Various San José Pipeline Diameter Options C-3

Table C-2. Cost Estimate Details: PL-Eff, 60-inch Effluent Pipeline from SJ/SC RWF to San José AWPF C-4

Table C-3. Cost Estimate Details: PL-Eff, 48-inch Effluent Pipeline from SJ/SC RWF to San José AWPF C-5

Table C-4. Cost Estimate Details: PL-O, 48-inch Purified Water Pipeline from San José AWPF to LGRP C-6

Table C-5. Cost Estimate Details: PL-S, 36-inch Purified Water Pipeline from San José AWPF to LGRP C-7

Table C-6. Cost Estimate Details: PL-Optimal 1, 36-inch Purified Water Pipeline from AWPF to Levi’s Stadium C-8

Table C-7. Cost Estimate Details: PL-Optimal 1, 24-inch Purified Water Pipeline from AWPF to Levi’s Stadium C-9

Table C-8. Cost Estimate Details: PL-Optimal 2, 30-inch Purified Water Pipeline from Levi’s Stadium to Pruneridge C-10

Table C-9. Cost Estimate Details: PL-Optimal 2, 24-inch Purified Water Pipeline from Levi’s Stadium to Pruneridge C-11

Table C-10. Cost Estimate Details: PL-Optimal 3, 24-inch Purified Water Pipeline from Pruneridge to Los Gatos C-12

Table C-11. Cost Estimate Details: PS-OPI, Purified Water Pump Station from San José AWPF to LGRP to convey up to 24 mgd C-13

Table C-12. Cost Estimate Details: PS-OPF, Purified Water Pump Station from San José AWPF to LGRP to convey up to 10 mgd C-15

List of Abbreviations

AF	acre-foot/acre-feet
AFY	acre-feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
CIP	clean in place
CoRe Plan	Countywide Water Reuse Master Plan
County	Santa Clara County
ENR	Engineering News Record
FAT	full advanced treatment
ft	foot/feet
gpm	gallon(s) per minute
GWR	groundwater recharge
in	inch/inches
LGRP	Los Gatos recharge ponds system
M	million(s)
mgd	million gallons per day
O&M	operations and maintenance
O_3-BAC	ozone-biologically active carbon
P3	public-private partnership
PL	pipeline
PS	pump station
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWA	raw water augmentation
SFPUC	San Francisco Public Utilities Commission
SJ Muni	San José Municipal Water System
SJ/SC RWF	San José/Santa Clara Regional Wastewater Facility
SJW	San Jose Water[1]
SVAWPC	Silicon Valley Advanced Water Purification Center
TDH	total dynamic head
TM	technical memorandum
TWA	treated water augmentation
UF	ultrafiltration
UV/AOP	ultraviolet/advanced oxidation process
VW	Valley Water
WTP	Water Treatment Plant

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[1] San Jose Water does not use an accent in their name, though City of San José does.

PREFACE: A LIVING DOCUMENT

The Countywide Water Reuse Master Plan (CoRe Plan) is envisioned to be a living document to support future decision-making related to Valley Water's recycled (non-potable reuse) and purified water (potable reuse) programs. As direct potable reuse (DPR) regulations and other influencing factors/conditions (e.g., advances in treatment technologies) continue to evolve and fundamentally change the basis of projects, Valley Water will review and assess such updates relative to the CoRe Plan. As described here, the adaptability incorporated into Valley Water's approach is already being tested and demonstrated.

As Valley Water and its project team were finalizing this CoRe Plan, the State Water Resources Control Board's Division of Drinking Water released an initial draft of DPR regulations on March 22, 2021. With initial draft regulations becoming available after a multi-year effort to complete the CoRe Plan—including development of preliminary treatment trains for DPR portfolios (both raw water augmentation and treated water augmentation) and a regulatory compliance assessment—Valley Water and its project team performed a cursory review of the initial draft regulations and found the anticipated DPR requirements identified in the CoRe Plan adhere closely to those in the draft regulations. Significant elements of the draft regulation include:

- **Technical, managerial, and financial (TMF) capacity**: The draft regulations significantly increase required TMF capacity for DPR projects and clarify the State Board's proposed approach for evaluating TMF capacity of a DPR project's responsible agency (e.g., Valley Water) and respective project partners. The State Board will evaluate TMF capacity across multiple domains, including funding continuity, interagency agreements, staffing, and operator certification. Compliance will require documentation through an extensive suite of reports, programs, and plans beyond those currently required for indirect potable reuse (IPR) projects.
- **Chemical control**: The draft regulations include prescriptive requirements for additional treatment (including design, operation, and performance), expanded monitoring requirements, significant expansion of source control programs, and more stringent control and response limits.
- **Pathogens**: DPR will require significantly higher log reduction value requirements than IPR for all pathogens. The regulations further clarify how those values must be met in terms of the number, types, and diversity of barriers, as well as protocols for validation and continuous verification of the performance of each treatment process.
- **Monitoring and control**: the draft regulations require a higher degree of monitoring (i.e., frequency, locations, and range of contaminants) and more stringent operational control (e.g., automatic diversions and shutdowns) to prevent distribution of water that is not compliant with requirements.

Because many of these requirements were anticipated, the DPR treatment trains included in the CoRe Plan will comply with most of the draft requirements without significant alterations to the process trains. However, the draft regulations have a larger impact on the regulatory compliance assessment given the clarification on several topics previously less defined, such as enhanced source control and TMF capacity requirements.

Valley Water will continue to monitor DPR regulatory development and associated impacts to the CoRe Plan and will provide necessary updates to maintain the efficacy of this planning document for future potable reuse implementation.

Section 1: Introduction

The Countywide Water Reuse Master Plan (CoRe Plan) evaluates reuse opportunities—individual projects and collective portfolios that combine projects—and considers implementation pathways to increase the region's water supply reliability through potable reuse over a planning horizon of 2040. As an outcome of that work, this planning-level document considers several scenarios for advancing potable reuse projects identified in the CoRe Plan with some variations (namely production capacity) and repackaging. The scenarios build on Valley Water's (VW) intention to design and construct a near-term project using a flexible implementation approach that can support potential reuse expansion in the future.

For this planning-level effort, the following concepts and terms are applied throughout this technical memorandum (TM).

- **Flexible implementation approach** – Refers to a prudent planning approach to design and construct a near-term groundwater recharge (GWR) project (anticipated by 2028) with sufficient flexibility to support potential future expansion. Key aspects of this approach include the following.
  - VW plans to construct an advanced water purification facility (AWPF) with a production capacity of 10 million gallons per day (mgd) for GWR. The near-term project involves design and construction of a pipeline to convey purified water from the AWPF to the Los Gatos recharge ponds system (LGRP, or LGRS[2]) for GWR via surface spreading.
  - The purpose of using a flexible implementation approach is to consider design aspects at the outset that can support potential future expansion of the 10-mgd facility by increasing the production capacity by an additional 14 mgd, for a total capacity of up to 24 mgd.
  - Potential future expansion may involve:
    1. Increases to treatment facility hydraulic capacity and purified water deliveries,
    2. Opportunities for future implementation of direct potable reuse (DPR) once the state issues applicable regulations, and
    3. Enhancements of treatment processes as applicable based on reuse type or changes in regulatory requirements.
- **Flexible expansion** – Refers to potential expansion of the near-term project to provide additional purified water treatment capacity in the future.
- **GWR, raw water augmentation (RWA), and treated water augmentation (TWA) Flex** – Refer to the three scenarios evaluated for flexible expansion (Figure 1-1). Each involves increasing the production capacity of the near-term 10-mgd AWPF, resulting in up to 24 mgd of purified water for the following types of reuse:
  - GWR, referred to as *GWR Flex*
  - GWR and RWA, referred to as *RWA Flex*
  - GWR and TWA, referred to as *TWA Flex*

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[2] Valley Water's system of recharge ponds located in Los Gatos are referred to as Los Gatos Recharge Ponds (LGRP) system in past documents. In recent documents and going forward, Valley Water is referring to the same facility as Los Gatos recharge system (LGRS).

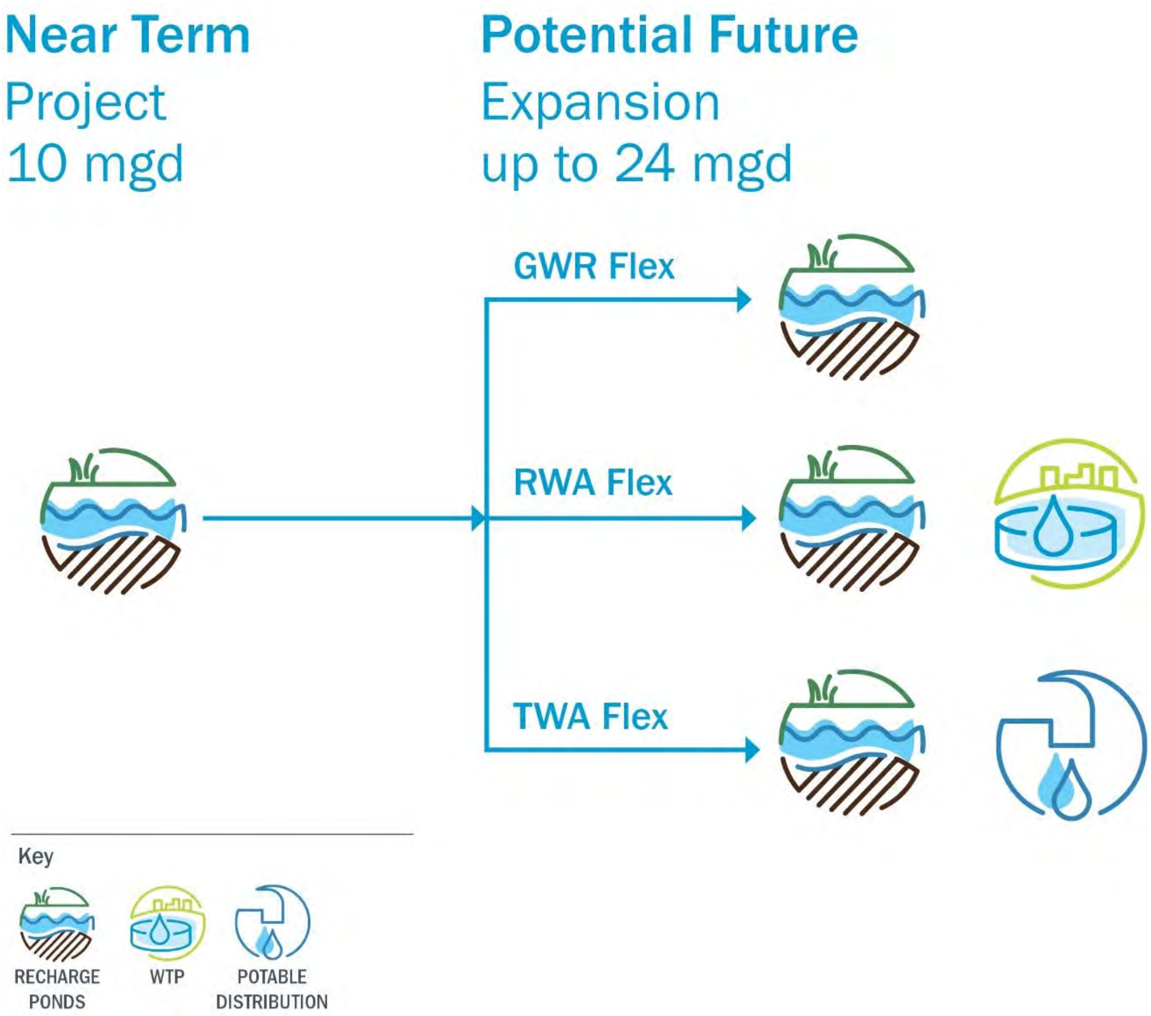

Figure 1-1. Flexible implementation involves advancing a near-term GWR project designed and constructed to enable potential future expansion

While the near-term project is definitively GWR, various conditions, events, or processes may trigger, or hinder, future expansion to GWR, RWA, or TWA Flex, such as reliability of other water supplies[3]; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand. Flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities.

The scope of this TM involves teasing apart and reassembling Class 5 cost estimates developed for the CoRe Plan based on the smaller production capacity for the near-term project (i.e., 10 mgd instead of 24 mgd) and characteristics of the flexible expansion under each scenario considered. The cost estimates are based on vendor quotes specific to proposed facilities, historical construction estimates, historical costs, and professional experience with similar projects. Some operations costs scale down proportionally from the 24 mgd estimates used in the CoRe Plan to 10 mgd, such as the costs of purchasing source water supply for reuse and operating reverse osmosis concentrate (ROC) management. Cost estimate assumptions and calculations are summarized in Attachment B.

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[3] Factors that influence supply reliability may include, but are not limited to, water supply agreements/contracts, hydrologic conditions (i.e., droughts, climate change), evolving and new regulations, natural disasters (e.g., earthquakes, wildfires), and/or human-induced threats.

The CoRe Plan appendices complement this TM with more detailed information. Relevant appendices include the following (Appendices D, E, and F are less relevant):

- **Appendix A-1:** Feasible Project Portfolios
- **Appendix A-2:** Compendium of flow assessments, facility design capacity, and annual yield calculations
- **Appendix A-3:** Treatment facilities' design criteria and sizing calculations
- **Appendix A-4:** Process flow diagrams and site layouts
- **Appendix A-5:** Basis of costs for project elements (i.e., inputs, assumptions, methods, and sources)
- **Appendix A-6:** Conceptual estimates for project elements' costs (i.e., line-item costs for AWPFs, pump stations, pipelines, and system interties)
- **Appendix A-7:** Expanded evaluation and risk assessment
- **Appendix A-8:** TWA pre-screening analysis
- **Appendix A-9:** Evaluation of Onsite Reuse in Santa Clara County
- **Appendix A-11:** Flexible Implementation of Potable Reuse – via Palo Alto AWPF
- **Appendix B:** Regulatory compliance
- **Appendix C:** Hydraulic modeling
- **Appendix G:** ROC management strategies

Section 2: Project Characteristics

Some project components, such as treatment equipment for purification processes related to GWR and purified water storage/pump station(s), can be sized according to the near-term project's capacity (10 mgd)[4] and expanded in the event VW decides to increase the capacity in the future. Yet, the flexible implementation approach requires beginning with the end in mind, such that the near-term project is designed and constructed to enable future expansion as contemplated under the GWR, RWA, and TWA Flex scenarios.

Each future expansion scenario considered in this TM is assumed to increase capacity of the 10-mgd AWPF to 24 mgd and treat all flow to the highest quality required by the delivery points (reuse type). For example, TWA Flex would treat all flow from the 24 mgd facility to TWA quality, even though part of the flow would be delivered to LGRP. Potential future expansion is critically linked to the following aspects of the near-term project:

- **Pipelines to convey 24 mgd of purified water from the AWPF to LGRP.** While the CoRe Plan includes 48-inch diameter pipe for conveyance, the flex scenarios reduce that to 36-inch diameter pipe. This decision balances the ability to convey up to 24 mgd of flow in the future.
- **ROC management facilities** sized to manage the anticipated volume of 4.24 mgd ROC from an expanded 24-mgd AWPF. In the near-term, the 10 mgd AWPF is estimated to produce approximately 1.76 mgd ROC. Estimated volumes and costs for ROC management are based on "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD.
- **Site layout and footprint for a 24-mgd capacity AWPF** with sufficient space for the respective treatment processes, process building footprint, and facilities to meet requirements of anticipated reuse types.

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[4] The annual energy demand related to the near-term 10 mgd project with source water originating from the SJ/SC RWF is estimated at 20,834 MWh/yr.

That is, to implement either RWA Flex or TWA Flex in the future, treatment is anticipated to require additional processes for the full 24 mgd regardless of amount used for GWR at any given time. In addition, the site layout requires sufficient space to considering the turning radius of trucks that require site access for activities such as chemical deliveries, emergency services, and construction of the expanded facility.

- **Land acquisition and site preparation** to accommodate the 24-mgd AWPF's site layout and footprint

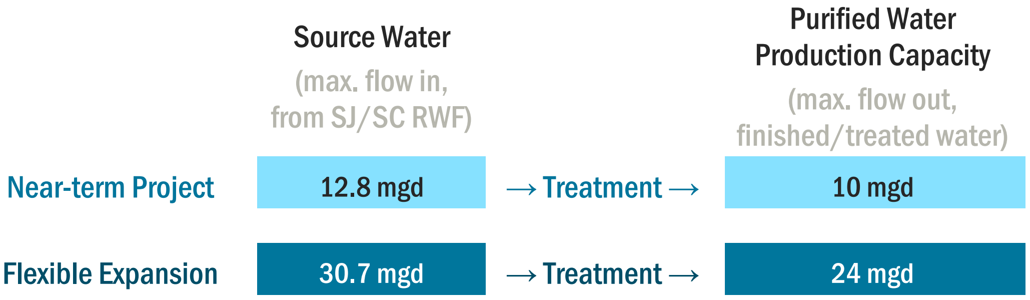
It is assumed that the AWPF would shut down during construction to expand the facility and that membranes from the near-term project are feasible for continued use (as their life cycle allows) in a future RWA or TWA application.

The reuse treatment facilities are distinguished by the following characteristics:

- **Source water** refers to the origin (agency/facility) of wastewater for reuse. For this evaluation, source water will be from the San José/Santa Clara Regional Wastewater Facility (SJ/SC RWF). An evaluation of source water flows is included in Appendices A-1 and A-2 of the CoRe Plan.
- **Treatment level (or type of reuse)** refers to treatment extent based on type of reuse (GWR via surface spreading, RWA, and TWA). Minimum treatment levels include:
  - For GWR: Full advanced treatment (FAT), as required by VW
  - For RWA: FAT along with ozone-biologically active carbon (O_3-BAC), post-treatment stabilization and free chlorine disinfection
  - For TWA: FAT, O_3-BAC, free chlorine disinfection, chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time
- **Delivery point** refers to the facility/location where purified water is delivered for reuse. Ultimate delivery points include:
  - For GWR: LGRP
  - For RWA: Rinconada Water Treatment Plan (WTP)
  - For TWA: Potable (treated) water distribution system connections, as described in Attachment A of this TM

2.1 Treatment Capacity Assumptions

Figure 2-1 summarizes treatment capacity assumptions for the near-term project and flexible expansion (GWR, RWA, and TWA Flex scenarios).



	Source Water (max. flow in, from SJ/SC RWF)		Purified Water Production Capacity (max. flow out, finished/treated water)
Near-term Project	12.8 mgd	→ Treatment →	10 mgd
Flexible Expansion	30.7 mgd	→ Treatment →	24 mgd

Figure 2-1. Assumed source water flow rates and production capacities for flex implementation

2.2 Treatment Level

Consistent with the CoRe Plan, this TM assumes GWR requires FAT processes, including membrane filtration, reverse osmosis (RO), and ultraviolet/advanced oxidation process (UV/AOP), as shown in the process flow diagram in Figure 2-2.

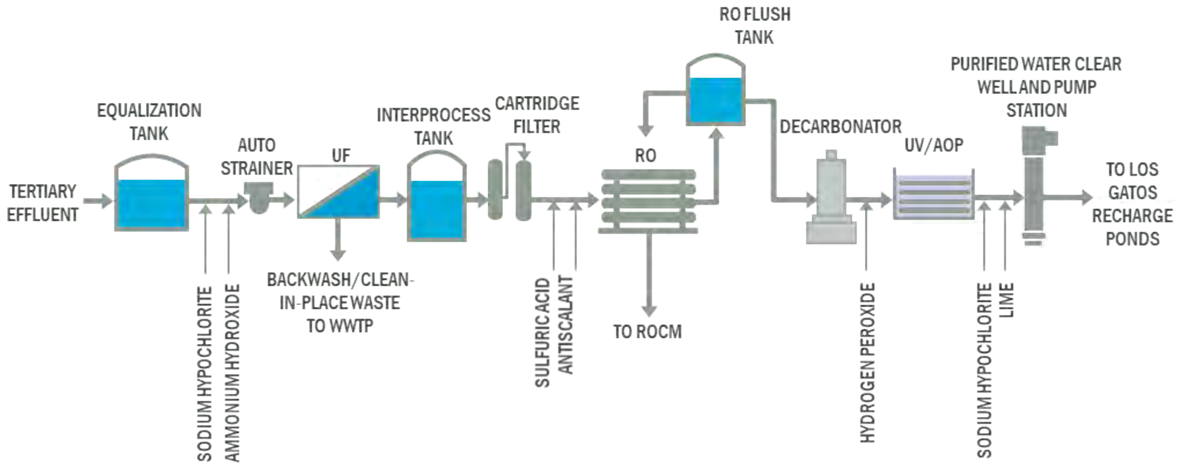


Figure 2-2. AWPF process flow diagram for the near-term project and GWR Flex

To meet anticipated regulatory requirements, RWA Flex is likely to require FAT as a minimum baseline level of treatment, along with O_3-BAC pretreatment and free chlorine disinfection for pathogen and chemical control (blue dashed line in the process flow diagram in Figure 2-3).

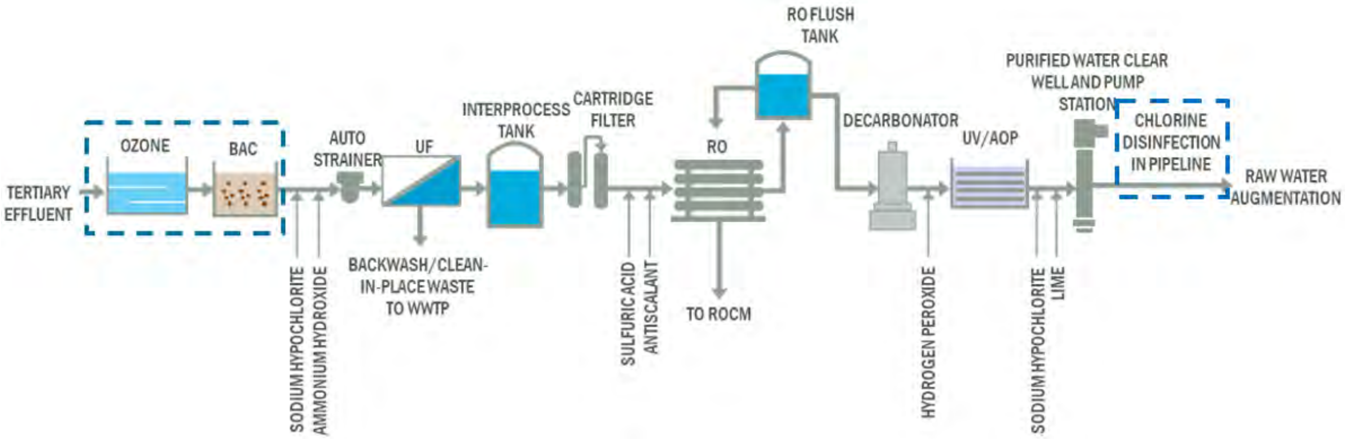


Figure 2-3. AWPF process flow diagram for RWA Flex

TWA Flex is anticipated to require O_3-BAC upstream of membrane filtration. In addition, the downstream end is anticipated to require chorine disinfection, air stripping facilities, and an eight-hour clearwell (blue dashed line in Figure 2-4). With ample pathogen reduction in the treatment processes for RWA, the TWA treatment train focuses on additional chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time. This treatment train considers the potential to demonstrate higher pathogen log reduction value for the upstream wastewater treatment plant or RO, if needed.

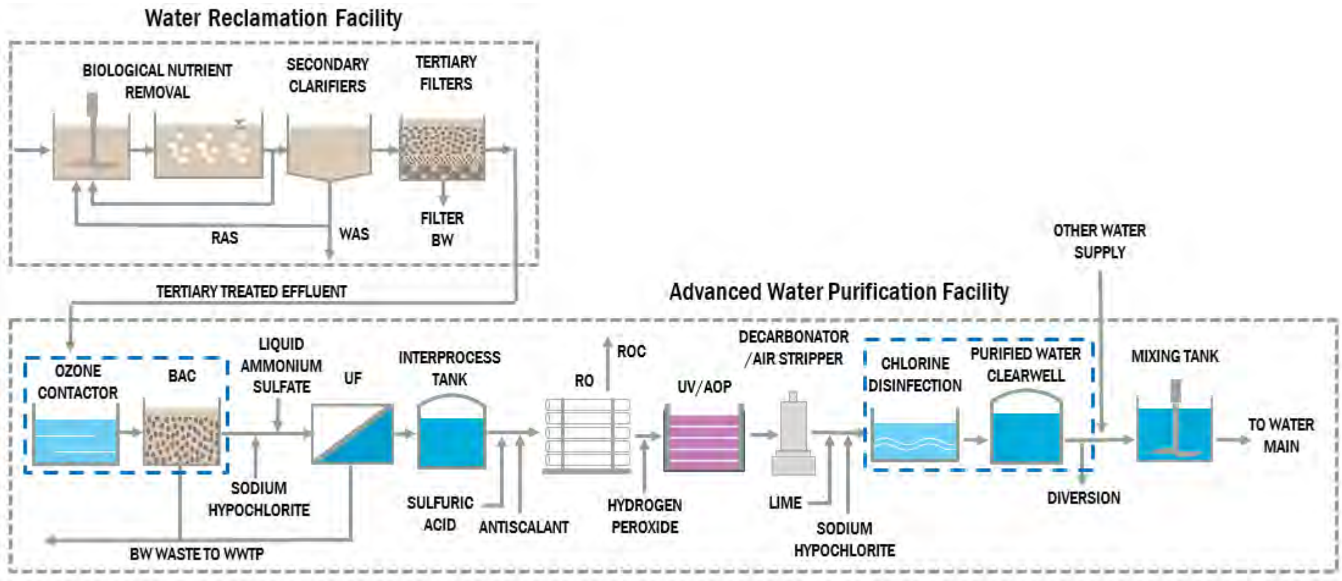


Figure 2-4. AWPF process flow diagram for TWA Flex

Details and assumptions of the treatment processes, including pathogen reduction and chemical control, are summarized in Appendix A-1 of the CoRe Plan.

Section 3: San José Flex Scenarios

As described above, three flex scenarios are potable reuse project elements from the CoRe Plan that are resized and repackaged to allow for potential incremental expansion. These scenarios have flexible expansion capacity up to 24 mgd for GWR, RWA, or TWA. The three scenarios are described in further detail in the following sections.

3.1 GWR Flex

San José GWR Flex is premised on treating effluent from the SJ/SC RWF at a new AWPF located in San José at a site adjacent to the existing Silicon Valley Advanced Water Purification Center (SVAWPC). The AWPF would produce up to 10 mgd in the near term and up to 24 mgd with potential future expansion for GWR at LGRP. The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd.

Besides a new AWPF, GWR Flex project elements include ROC management and purified water conveyance from the AWPF to LGRP and infrastructure improvements at LGRP to integrate purified water into the existing system (Table 3-1). The proposed 18-mile pipeline from the AWPF to LGRP is sized to convey up to 24 mgd of potential future flow and traverses through highly urbanized settings with significant utilities and temporary community disruption. Infrastructure improvements at LGRP would support operational flexibility, allowing ponds to be maintained without impacting the entire complex. Conveyance and LGRP infrastructure improvements would be built as part of the near-term project and sized to accommodate flexible expansion.

Table 3-1. San José GWR Flex Project Elements

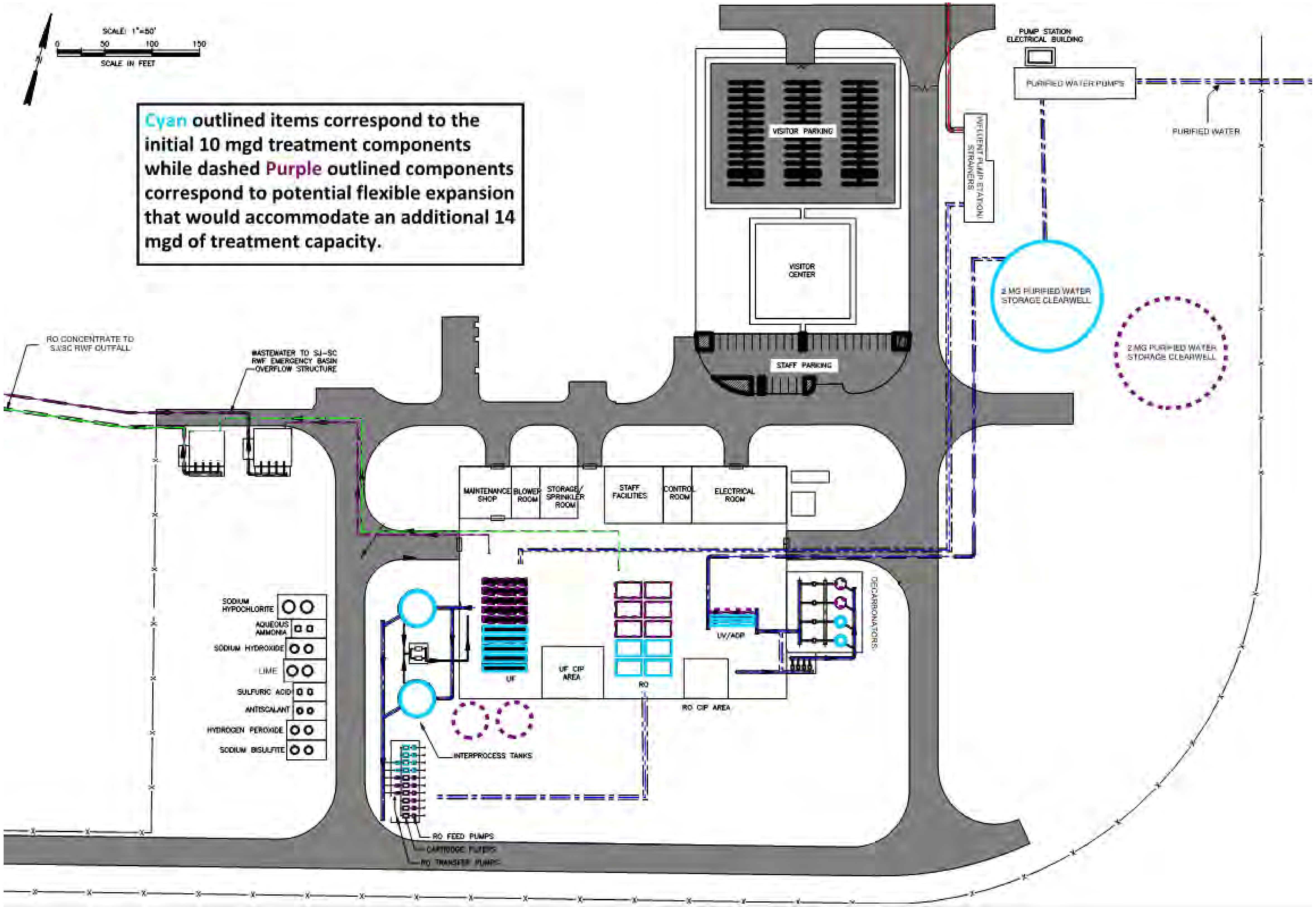
Element		Capacity (mgd)	
San José AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump station		**Capacity (gpm)**	**TDH (ft)**
PS-1 (purified water to LGRP)	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-1 (effluent from SJ/SC RWF to San José AWPF)	Near-Term	60”	2,000’
PL-2 (purified water from San José AWPF to LGRP)	Near-Term	36”	95,500’
ROC pipeline [b]	Near-Term	18”	9,600’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (Valley Water, 2018)		

a. Potential future expansion requires hydraulic expansion to produce up to 24 mgd treated to GWR water quality requirements.

b. ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD (attached to the CoRe Plan as Appendix G)

ft = foot/feet
gpm = gallon(s) per minute
in = inch/inches
PL = pipeline
PS = pump station
TDH = total dynamic head

While Figure 3-1 shows a detailed site layout for near-term and flexible expansion capacities located to the south and east of the SVAWPC, Figure 3-2 depicts a proposed alternative AWPF site location east of the SVAWPC. Further environmental study, engineering analysis, and cost estimates for alternative siting and layout are needed prior to finalizing site selection and are not reflected in this Flex TM. The proposed pipeline alignment from the AWPF to LGRP is shown in Figure 3-3.



Cyan outlined items correspond to the initial 10 mgd treatment components while dashed Purple outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity.

Figure 3-1. Site layout for San José GWR Flex

Note: CIP = clean in place, UF = ultrafiltration, UV/AOP = ultraviolet/advanced oxidation process

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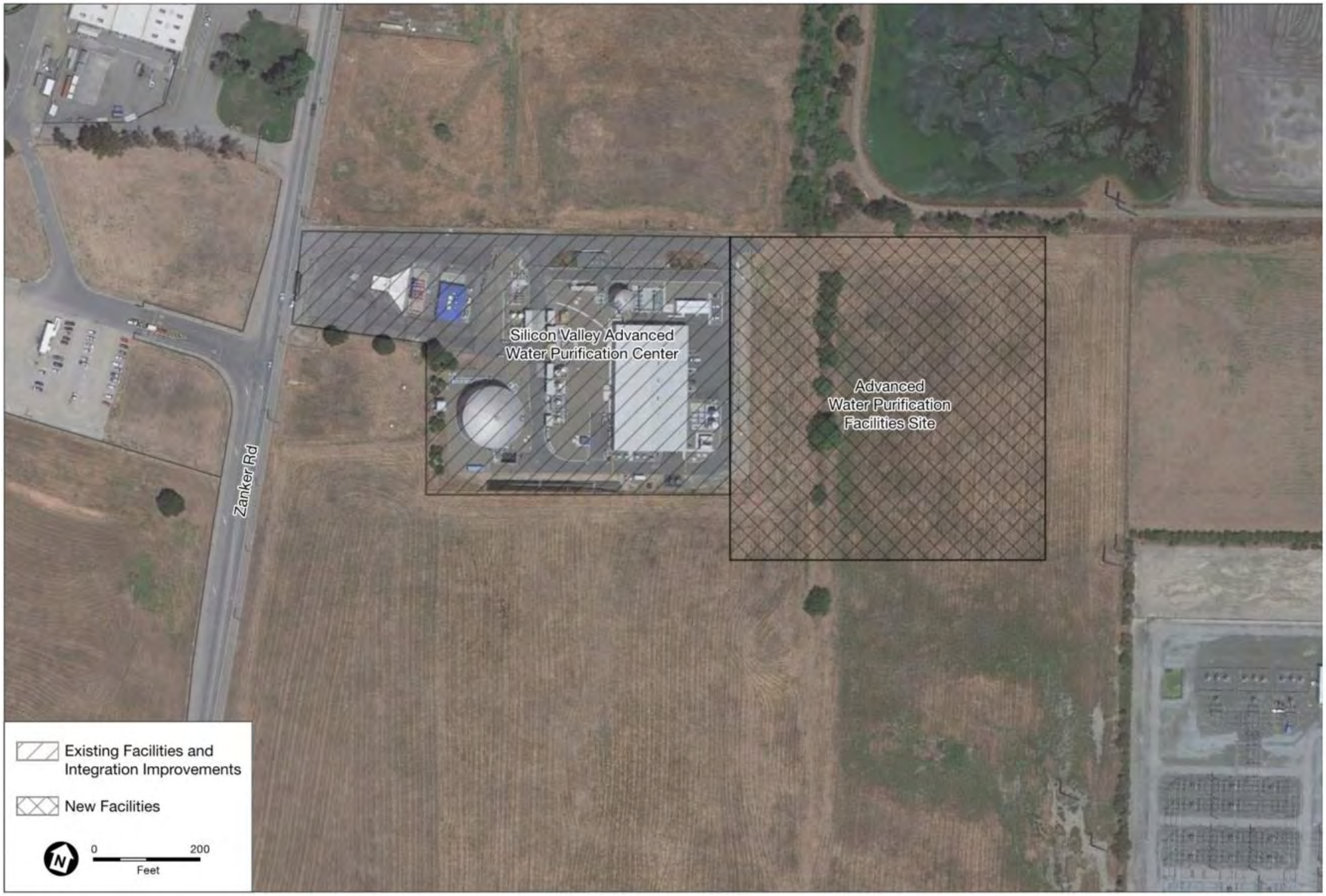

Silicon Valley Advanced Water Purification Center
Advanced Water Purification Facilities Site
Zanker Rd
Existing Facilities and Integration Improvements
New Facilities
N
0
200
Feet

Source: ESA, 2020 and Google Earth, 2020

Figure 3-2. San José AWPF preferred project site location and vicinity

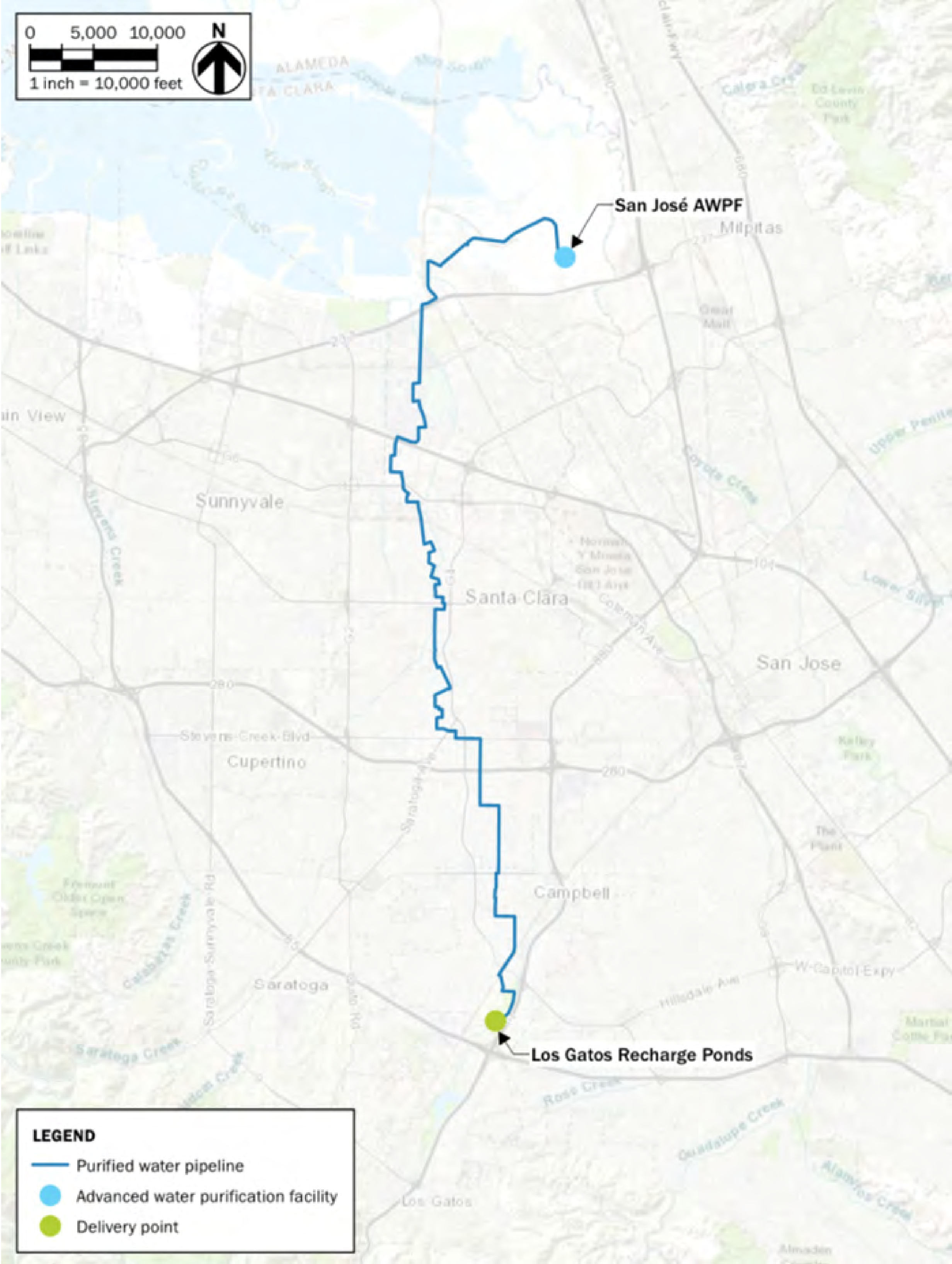


Figure 3-3. Map of San José near-term project and GWR Flex facilities and delivery point (LGRP)

Table 3-2 contains estimated capital and annual operations and maintenance (O&M) costs for GWR Flex, presented in 2019 dollars. Further cost details are included in Attachment B.

Table 3-2. Estimated Costs for San José GWR Flex

Element	Capital Cost[a] ($2019, in millions)			Annual O&M Cost[a] ($2019, in millions)		
	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd)[b]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd)[b]	Total (24 mgd)
San José AWPF	$210	$145	$355	$5.9	$7.5	$13.4
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF), 60-inch Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to LGRP), 36-inch LGRP improvements Pipeline easements	$245	$15	$260	$1.8	$1.8	$3.6
Annual source water purchase	--	--	--	$1.0	$1.4	$2.4
ROC management (existing outfall)[c]	$20	--	$20	$0.8	$1.1	$1.9
Total[d]	**$475**	**$160**	**$635**	**$9.5**	**$11.8**	**$21.3**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *Expansion capital and O&M costs reflect modifications and construction to increase the 10 mgd facility by an additional 14 mgd.*

c. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the Engineering News Record (ENR) Construction Cost Index for San Francisco.*

d. *Does not include costs for visitor center*

The estimated unit cost for the San José GWR Flex near-term 10 mgd project over 30-year and 100-year life cycles would be $3,300/AF and $2,600/AF, respectively. This estimate includes capital, O&M, renewal and replacement, and source water purchase and does not include future flex expansion as part of the life cycle. The purified water pipeline to LGRP is sized at 36-inches for the near-term project to accommodate potential future expansion to 24 mgd. CoRe Plan portfolios use a 48-inch purified water pipeline to LGRP. For additional detail, refer to the following:

- Methodology for estimating life-cycle costs: Refer to Appendix A-5 of the CoRe Plan
- Cost tables for conveyance infrastructure that is a consistent size in the CoRe Plan and this Flex TM: Refer to Appendix A-6 of the CoRe Plan
- Tables with life-cycle cost details: See Attachment B, Table B-14

3.2 RWA Flex

San José RWA Flex is premised on treating effluent from the SJ/SC RWF at a new AWPF located in San José at a site adjacent to the existing SVAWPC. The AWPF would produce up to 10 mgd in the near term for GWR at LGRP. In the future, the AWPF could be expanded by up to 14 mgd in production capacity, for a total capacity of 24 mgd for potable reuse via GWR at LGRP and/or RWA at Rinconada WTP. The expansion would involve increasing the AWPF's hydraulic capacity and adding treatment processes anticipated for forthcoming RWA requirements, such as O_3-BAC.

The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment processes/equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd. The site layout for near-term and flexible expansion capacities is shown in Figure 3-4.

RWA Flex includes the same project elements as GWR Flex, along with a new booster pump station and pipeline to convey water from Vasona Ponds to Rinconada WTP as part of the potential future expansion (Table 3-3). The pump station is sized to convey up to 24 mgd through a 36-inch pipe to Rinconada WTP, same as the upstream pipeline capacity to pump to LGRP. That is, up to 24 mgd could be delivered to either Rinconada WTP or LGRP. Assuming an average delivery of 10 to 14 mgd to Rinconada WTP, the remaining 10 to 14 mgd would be delivered to LGRP. O&M costs for pumping to Rinconada WTP are based on an average flow of 12 mgd. The specific pump station location is not yet identified but assumed to be located on VW-owned property and absent of sensitive habitat. Given the proximity to the existing Vasona Pump Station, ample power is assumed to be available at the pump station.

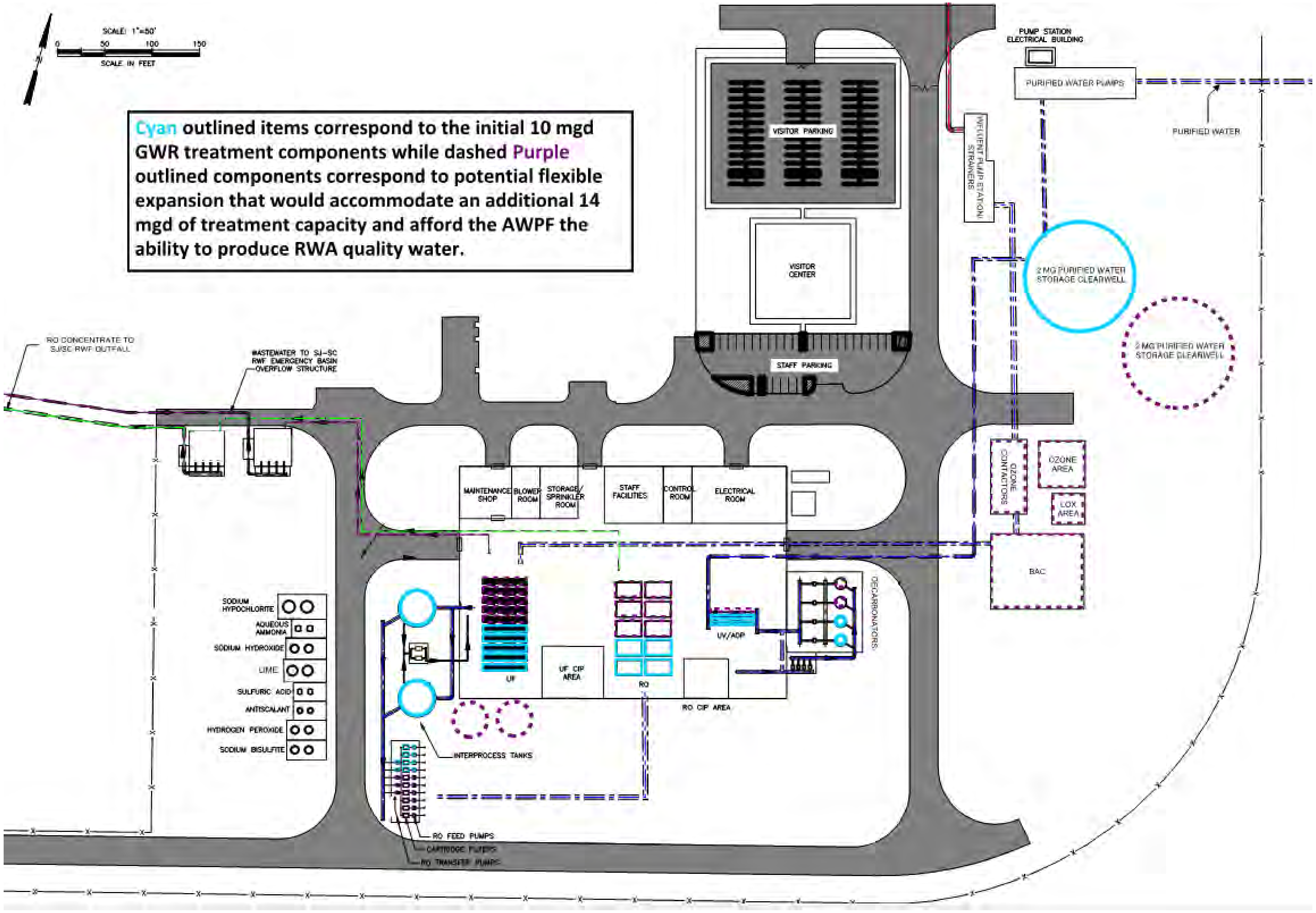
Table 3-3. San José RWA Flex Project Elements

Element		**Capacity (mgd)**	
San José AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump station		**Capacity (gpm)**	**TDH (ft)**
PS-1 (purified water to LGRP)	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Rinconada RWA booster pump station	Flexible Expansion	16,700	240’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-1 (effluent from SJ/SC RWF to San José AWPF)	Near-Term	60”	2,000’
PL-2 (purified water from San José AWPF to LGRP)	Near-Term	36”	95,500’
ROC pipeline [b]	Near-Term	18”	9,600’
Rinconada RWA extension pipeline	Flexible Expansion	36”	12,400’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (Valley Water, 2018)		

a. *Potential future expansion requires hydraulic expansion and additional unit processes to produce up to 24 mgd treated to meet anticipated RWA water quality requirements.*

b. *ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD*

The proposed pipeline alignment from the AWPF to LGRP along with a new pipeline from LGRP to Rinconada that would be constructed as part of the flexible expansion for RWA are shown in Figure 3-5.



Cyan outlined items correspond to the initial 10 mgd GWR treatment components while dashed Purple outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity and afford the AWPF the ability to produce RWA quality water.

Figure 3-4. Site layout for San José RWA Flex

Note: CIP = clean in place, UF = ultrafiltration, UV/AOP = ultraviolet/advanced oxidation process

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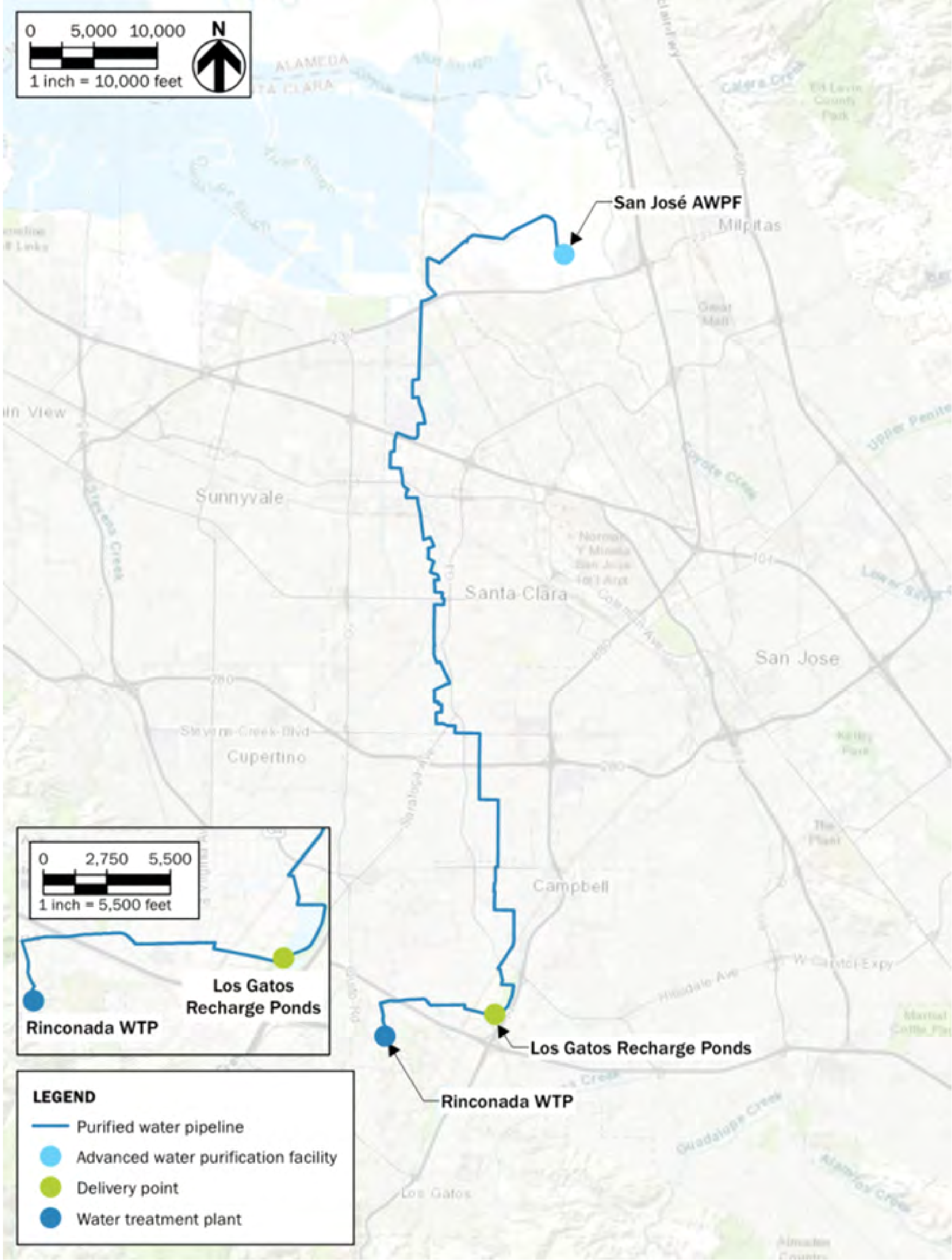


Figure 3-5. Map of San José RWA Flex facilities and delivery points (LGRP and Rinconada WTP)

Table 3-4 contains estimated capital and annual O&M costs for RWA Flex, presented in 2019 dollars. Further cost details are included in Attachment B.

Table 3-4. Estimated Costs for San José RWA Flex

	Capital Cost [a] ($2019, in millions)			Annual O&M Cost [a] ($2019, in millions)		
Element	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [b]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [b]	Total (24 mgd)
San José AWPF	$210	$190	$400	$6.1	$9.8	$15.9
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to LGRP) LGRP improvements Rinconada RWA booster pump station Rinconada RWA extension pipeline Pipeline easements	$245	$55	$300	$1.8	$3.8	$5.6
Annual source water purchase	--	--	--	$1.0	$1.4	$2.4
ROC management (existing outfall) [c]	$20	--	$20	$0.8	$1.1	$1.9
Total [d]	**$475**	**$245**	**$720**	**$9.7**	**$16.1**	**$25.8**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *Expansion capital and O&M costs represent the incremental cost of modifications and construction to increase the 10 mgd facility by an additional 14 mgd.*

c. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.*

d. *Does not include costs for visitor center*

3.3 TWA Flex

San José TWA Flex is premised on treated effluent from the SJ/SC RWF at a new AWPF located in San José at a site adjacent to the existing SVAWPC. The AWPF would produce up to 10 mgd in the near term for GWR at LGRP.

In the future, the AWPF could be expanded by up to 14 mgd in production capacity, for a total capacity of 24 mgd for potable reuse via GWR at LGRP and/or TWA at several connections to local potable distribution systems proximate to the purified water pipeline that conveys flow from the AWPF to LGRP. These locations are shown in Figure 3-6 and described in Attachment A. The expansion would involve increasing the AWPF's hydraulic capacity and adding treatment processes anticipated for forthcoming TWA requirements, such as O_3-BAC, chlorine disinfection, air stripping facilities, and an eight-hour clearwell.

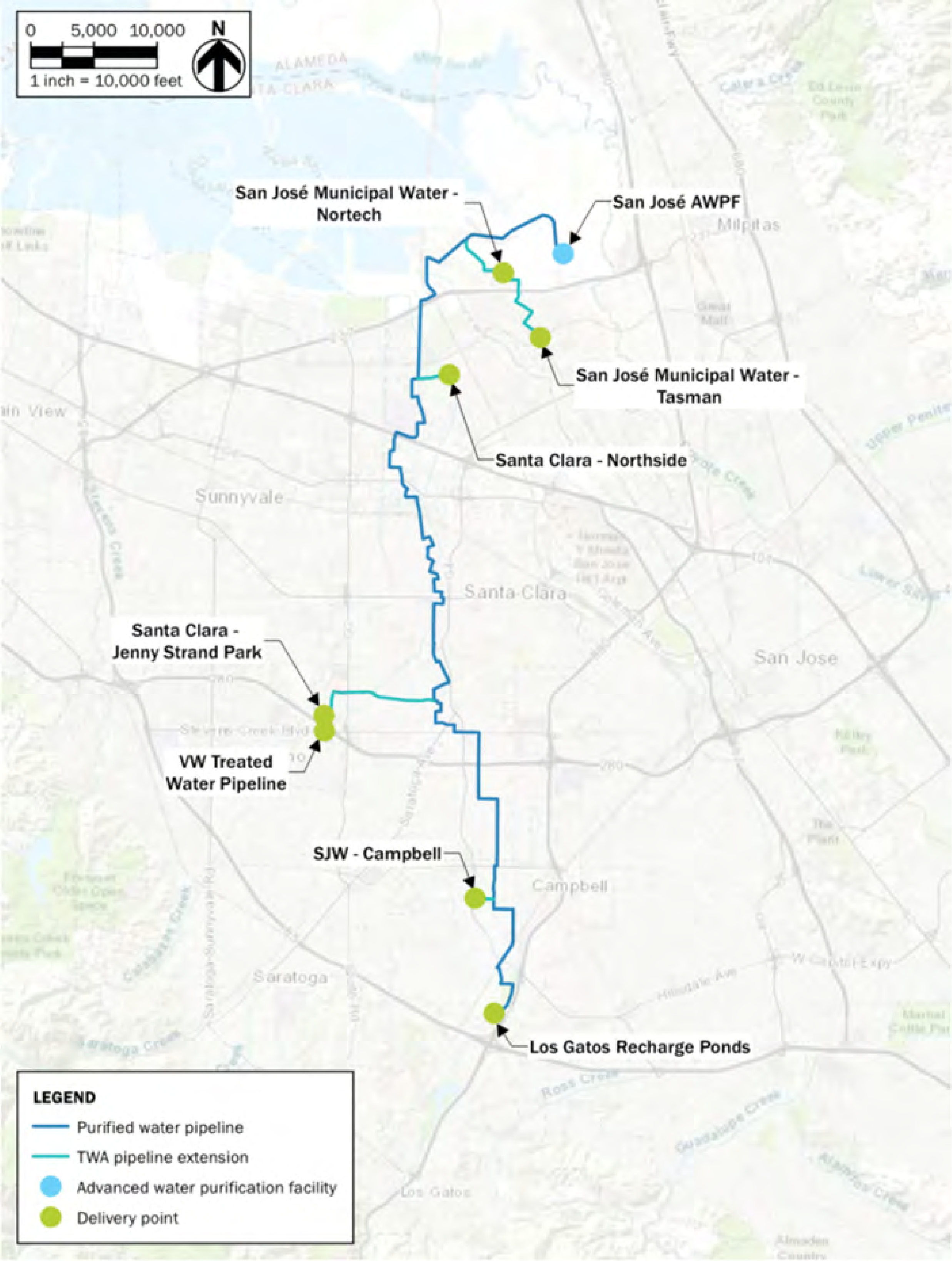


Figure 3-6. Map of San José TWA Flex facilities and delivery points (LGRP and potable distribution connections)

The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment processes/equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd. The site layout for near-term and flexible expansion capacities is shown in Figure 3-7.

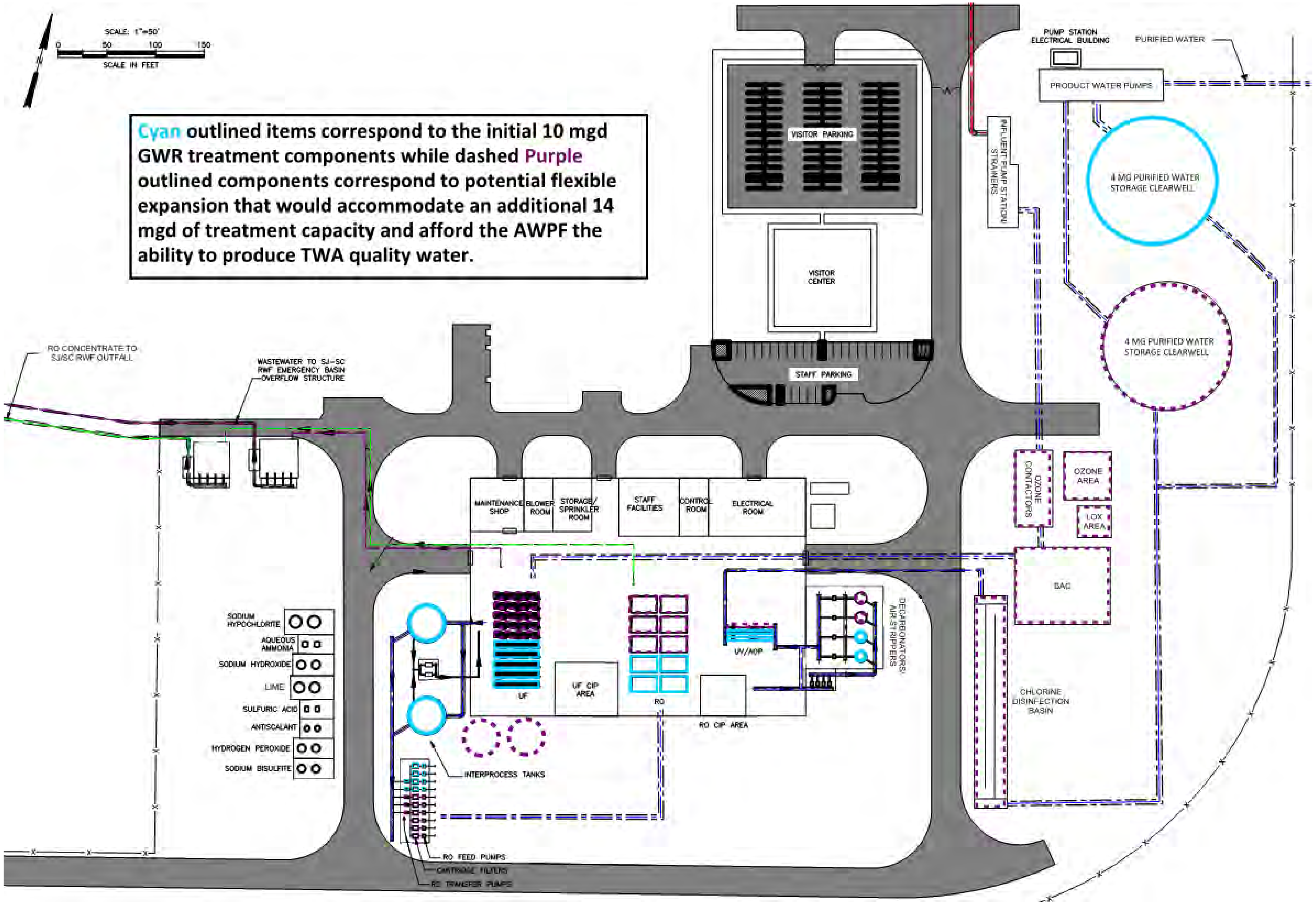
TWA Flex includes the same project elements as GWR Flex, along with six pipelines (or turnouts) to connect the purified water pipeline to potable water distribution system delivery points. Table 3-5 summarizes the project elements associated with TWA Flex.

Table 3-5. San José TWA Flex Project Elements

Treatment		Capacity (mgd)	
San José AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump station		**Capacity (gpm)**	**TDH (ft)**
PS-1 (purified water to LGRP)	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-1 (effluent from SJ/SC RWF to San José AWPF)	Near-Term	60”	2,000’
PL-2 (purified water from San José AWPF to LGRP)	Near-Term	36”	95,500’
ROC pipeline [b]	Near-Term	18”	9,600’
PL to San José Muni, Nortech/Tasman	Flexible Expansion	16”	13,200’
Santa Clara – Northside	Flexible Expansion	12”	2,600’
SJW – Campbell	Flexible Expansion	16”	1,600’
Santa Clara, Jenny Strand Park/ VW, treated water pipeline	Flexible Expansion	30”	11,200’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (Valley Water, 2018)		

a. *Potential future expansion requires hydraulic expansion and additional unit processes to produce up to 24 mgd treated to meet anticipated TWA water quality requirements.*

b. *ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD*



Cyan outlined items correspond to the initial 10 mgd GWR treatment components while dashed Purple outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity and afford the AWPF the ability to produce TWA quality water.

Figure 3-7. Site layout for San José TWA Flex

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Table 3-6 contains estimated capital and annual O&M costs for TWA Flex, presented in 2019 dollars. Further cost details are included in Attachment B.

Table 3-6. Estimated Costs for San José TWA Flex

	Capital Cost [a] ($2019, in millions)			Annual O&M Cost [a] ($2019, in millions)		
Element	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [b]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [b]	Total (24 mgd)
San José AWPF	$215	$195	$410	$6.1	$10.1	$16.2
Conveyance infrastructure Effluent pipeline (SJ/SC RWF to San José AWPF) Pump station (San José AWPF, purified water) Purified pipeline (San José AWPF to LGRP) TWA Pipelines (San José AWPF to various TWA delivery points) LGRP improvements Pipeline easements	$245	$50	$295	$1.8	$1.9	$3.7
Annual Potable Reuse Supply	--	--	--	$1.0	$1.4	$2.4
ROC Management (existing outfall) [c]	$20	--	$20	$0.8	$1.1	$1.9
Total [d]	**$480**	**$245**	**$725**	**$9.7**	**$14.5**	**$24.2**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *Expansion capital and O&M costs represent the incremental cost of modifications and construction to increase the 10 mgd facility by an additional 14 mgd.*

c. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.*

d. *Does not include costs for visitor center*

3.4 Flex Scenario Cost Comparison

Side-by-side graphical comparisons of near-term project and flex scenario capital and O&M costs are presented in Figures 3-8 and 3-9.

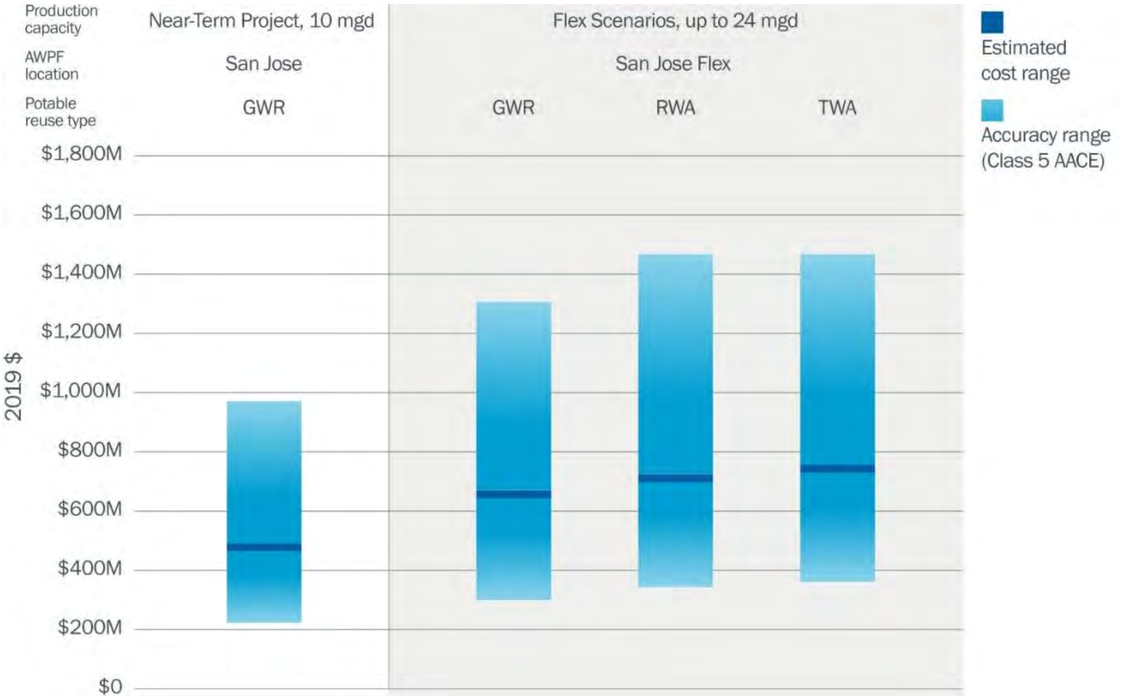

Figure 3-8. Estimated Capital Costs of San José Flexible Implementation Scenarios

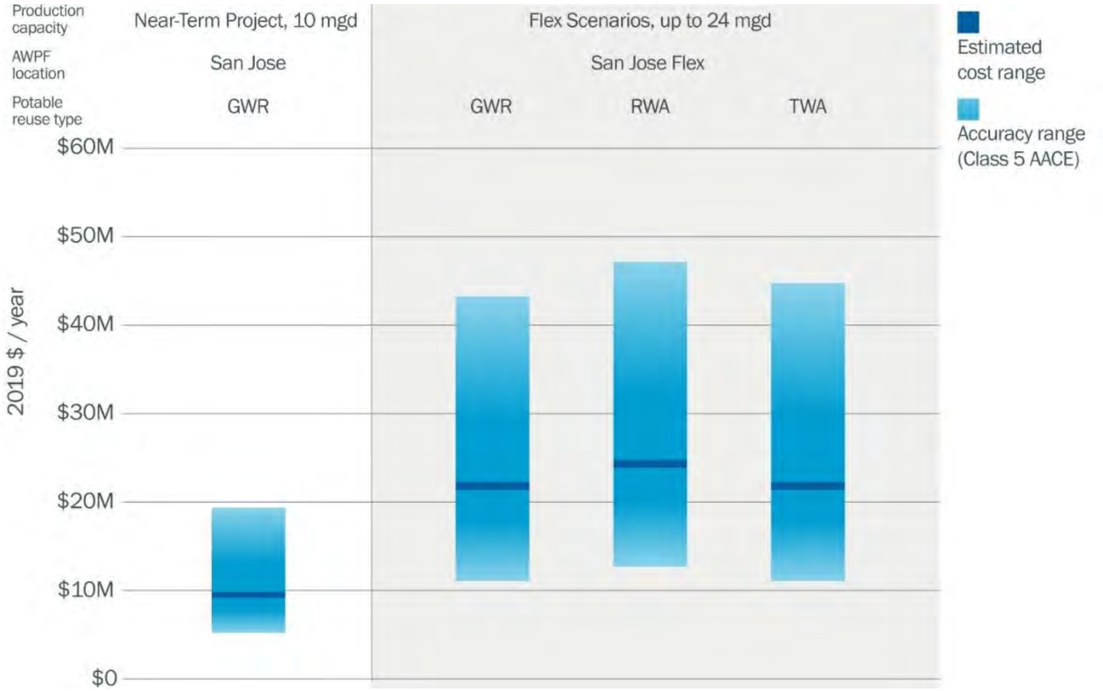

Figure 3-9. Estimated O&M Costs of San José Flexible Implementation Scenarios

Section 4: Pipeline Sizing Cost Evaluation

The project team conducted a high-level sensitivity evaluation to determine the cost impact of varying pipeline diameter for conveyance from the AWPF to LGRP. The evaluation relies on Portfolio 1a (SJ GWR) as a basis and modifies conveyance sizing and costs based on an assumed diameter for the pipeline delivering purified water to LGRP. This evaluation does not include the costs of pipelines to deliver TWA via potable distribution systems or RWA via Rinconada WTP.

Five purified water pipeline sizes (diameters) are presented in Table 4-1 and summarized as follows:

1. The first option is consistent with CoRe Plan Portfolio 1a (SJ GWR) and consists of a 48-inch pipeline diameter capable of conveying up to 40 mgd[5] of purified water flow to LGRP.
2. The second option is consistent with scenarios in this Flex TM and consists of a 36-inch pipeline to LGRP capable of conveying up to 24 mgd of purified water.
3. The third option is a pipeline with tapering diameter that allows Valley Water and its Partners to have up to 10 mgd of capacity available for GWR or RWA and up to 24 mgd of capacity available for TWA[6]. A tapered diameter pipeline could save capital cost while still delivering up to 24 mgd of purified water. As shown in Figure 4-1, the purified water pipeline has a 36-inch diameter before reducing to 30 inches following a large turnout at Levi's Stadium and Santa Clara's Northside Tanks. The pipeline then reduces again to a 24-inch diameter following another large turnout at Santa Clara's Serra/Jenny Strand Park tanks. The large turnouts are potential TWA delivery points mentioned in Section 3 and Attachment A.
4. The fourth pipeline size evaluated uses a 30-inch pipeline to LGRP to deliver up to 16 mgd.
5. The fifth pipeline size evaluated is a 24-inch pipeline to LGRP to deliver up to 10 mgd—which results in saving capital cost but limits future opportunities to deliver additional purified water.

These pipeline options and turnouts require additional study to confirm engineering feasibility and are included to conceptually define order-of-magnitude cost savings of reducing pipeline diameters. Cost details of each option are shown in Attachment C.

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[5] As considered in Valley Water's Purified Water Program Plan.

[6] Assuming an AWPF with 24 mgd production capacity, delivering 10 mgd as GWR leaves up to 14 mgd available for TWA. Delivering 5 mgd as GWR may leave up to 5 mgd for RWA and up to 14 mgd for TWA. Foregoing GWR and RWA may leave up to 24 mgd for TWA, though seasonal flow patterns may limit deliveries.

Table 4-1. Estimated Conveyance Costs under Various Scenarios for Purified Water Pipeline Diameter from San José AWPF to LGRP

Purified Water Pipeline Diameter (in)	Conveyance Capacity for AWPF Buildout (mgd)		Conveyance Costs ($M)		Notes
	TWA	GWR or RWA	Capital	Annual O&M	
48”	Up 40		$320	$3.4	Reflects CoRe Plan Portfolio 1a (SJ GWR) for 24 mgd, as originally conceived in SBWR Strategic Plan and considered in the Purified Water Program Plan (i.e., sized for future expansion, up to 40 mgd).
36”	Up to 24		$245	$3.4	Reflects the flex implementation near-term project and potential future expansion for San José flex. Cost shown do not include pipelines to deliver TWA (via potable distribution) or RWA (via Rinconada WTP).
Tapered/ graduated (36” to 30” to 24”)	Up to 14	Up to 10	$210	$3.4	Assumes up to 24 mgd of purified water, with 14 mgd for TWA and 10 mgd for GWR or RWA. Costs shown do not include pipelines to deliver TWA (via potable distribution) or RWA (via Rinconada WTP). Reduces diameter of the purified water pipeline from north to south after major turnouts (Figure 4-1); the diameter reduction from 36” to 30” occurs after Levi’s Stadium/Santa Clara Northside Tanks (where Santa Clara and potentially SFPUC can take purified water) and from 30” to 24” after Pruneridge Road (turnout to Santa Clara’s Serra/Jenny Strand Park tanks).
30”	Up to 16		$210	$2.4	Sized to deliver 16 mgd to any point along the purified water pipeline. Delivering more than 16 mgd requires a parallel pipeline and/or pump station
24”	Up to 10		$165	$1.7	Sized to deliver 10 mgd to any point along the purified water pipeline. Delivering more than 10 mgd requires a parallel pipeline and/or pump station.

a. *Unless otherwise noted, general design criteria apply as follows: minimum pressure = 25 psi; pipe head loss <10 feet per 1,000 LF of pipe; pipe velocity <7 fps (generally 5-7 fps); Hazen-Williams coefficient (C) = 130, ductile iron pipe; efficiency = 65%; and safety factor = 10%. Design capacity of portfolio pump stations is included in Appendix A-5 along with cost assumptions for conveyance and other elements.*

b. *Attachment C includes cost breakdown of pipeline size options.*

c. *Assumes that pipeline easement cost is $32/foot.*

d. *Costs are rounded up to the nearest $5M for capital and $0.1M for O&M. Difference in annual O&M due to reduced pipeline diameter is expected to be minimal.*

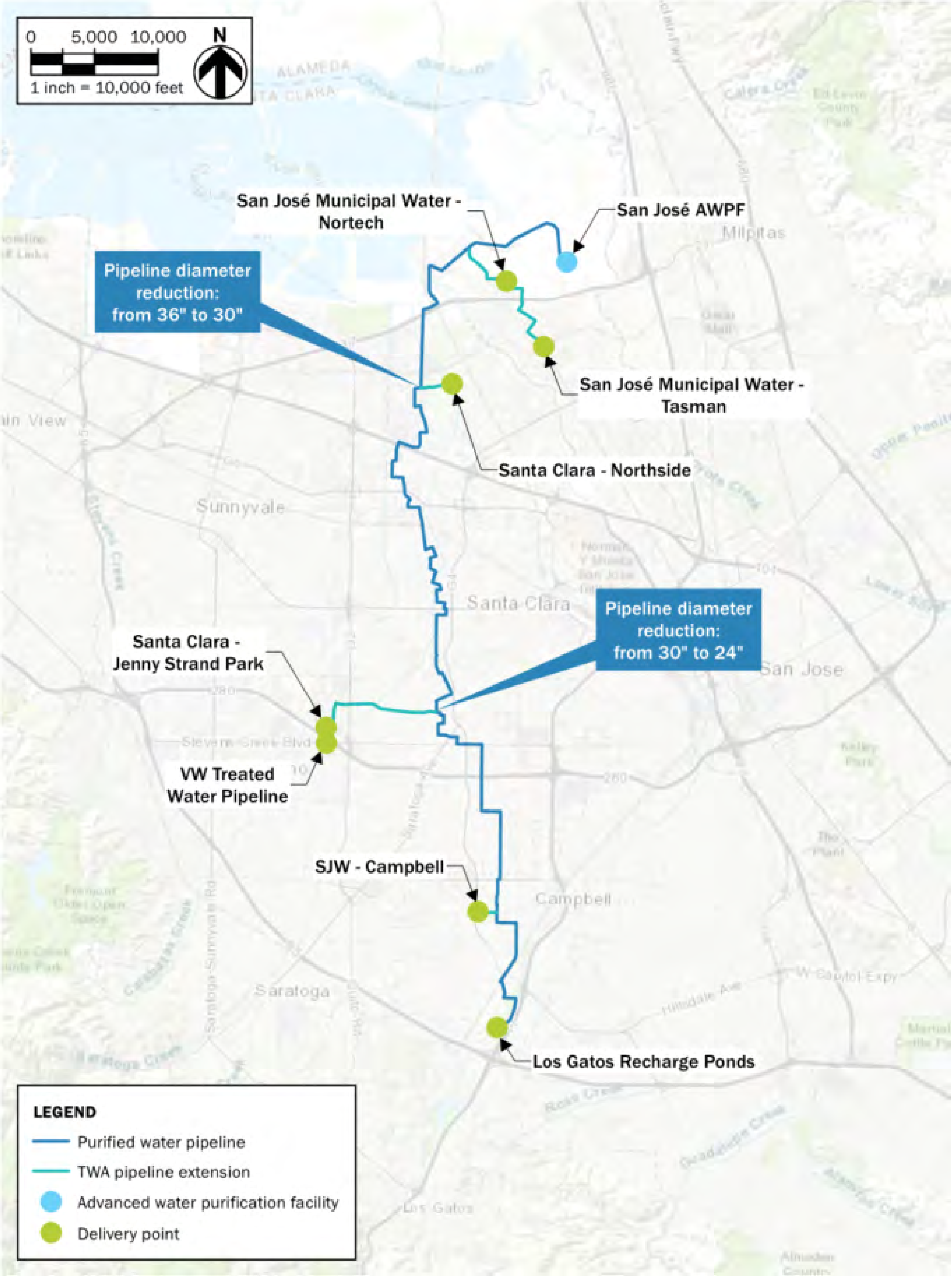
0 5,000 10,000
1 inch = 10,000 feet
N
San José Municipal Water - Nortech
San José AWPF
Pipeline diameter reduction: from 36" to 30"
San José Municipal Water - Tasman
Santa Clara - Northside
Pipeline diameter reduction: from 30" to 24"
Santa Clara - Jenny Strand Park
VW Treated Water Pipeline
SJW - Campbell
Los Gatos Recharge Ponds
Milpitas
Sunnyvale
Santa Clara
San Jose
Campbell
Saratoga
Los Gatos
LEGEND
Purified water pipeline
TWA pipeline extension
Advanced water purification facility
Delivery point

Figure 4-1. Facility locations, delivery points, and alignments for TWA Flex using pipelines tapered in diameter from the San José AWPF to LGRP

Section 5: Considerations for Next Steps

VW’s Board has directed staff to proceed with the design and construction of a near-term potable reuse project for a 10 mgd AWPF to yield approximately 11,000 AFY using a public-private partnership (P3) delivery method. Flexible implementation scenarios offer a prudent planning approach to meeting the Board directive, while leaving a pathway to expand purified water use in the County in the future.

As stated in the introduction, flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities. Although implementation of flex scenarios is not certain, factors that may influence a future expansion include reliability of other water supplies; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand.

Implementing a potable reuse project at San José is pending execution of agreements to define cost sharing, source water quantity and quality requirements, operational responsibilities, and other items. Valley Water and San José navigated similar issues in 2010 when negotiating the Recycled Water Facilities and Programs Integration Agreement for the existing 8-mgd SVAWPC. In 2019, Valley Water and Palo Alto executed a cost sharing and supply agreement to secure 9 mgd of effluent from Palo Alto. These past agreements provide a useful precedent for informing and guiding partnerships now and into the future. Next steps for implementation will be covered as part of the P3 project.

Attachment A: TWA Demand Assessment

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A.1 Treated Water Augmentation Demand Assessment

Estimated TWA demands along the GWR pipeline alignment were identified to assess potential future delivery points. Assumptions forming the basis of the TWA demand assessment follow.

- TWA deliveries are assumed to vary seasonally with lower demands during the winter (rainy season) and higher demands during the summer (dry season). Data on recent water use (2016 to 2019) within the retailer's service area are used to estimate the average, minimum, and maximum TWA deliveries for normal years and to size infrastructure that would connect the GWR pipeline to the TWA delivery point.
- In times of higher water demands, purified water deliveries are assumed to be prioritized for TWA over GWR.
- In times of lower water demands, more purified water is assumed to be delivered to LGRP for GWR or to VW's treated water pipeline for TWA, rather than directly to retailers' TWA delivery points.
- During dry years, purified water deliveries for TWA are assumed to increase when other supplies are limited and estimated based on current understanding of each retailer's water supply situation.

The San José TWA scenario is based on the proposed San José GWR pipeline alignment, which crosses through the San José Municipal Water System (SJ Muni), the City of Santa Clara (Santa Clara), and the San Jose Water (SJW) retailer service areas (see Section 3, Figure 3-5). Purified water for TWA could be delivered to each of these service areas from an expanded San José AWPF (with treatment processes added to the GWR treatment train, consistent with the CoRe Plan).

For preliminary planning purposes, delivery points are identified based on the proximity of existing turnouts and major water infrastructure facilities to the GWR alignment. VW is considering these delivery points as a guide to conceptually plan the requirements to deliver purified water for TWA to each retailer and, as a next step, to estimate associated costs. Table A-1 presents the estimated delivery rates at each TWA delivery point along the San José GWR alignment. Maximum deliveries reflect the assumed capacity of the lateral pipeline that would connect the GWR pipeline to the respective delivery point. To confirm the capacity to receive purified water for TWA, subsequent work would be required to hydraulically model the retailer's service area.

Table A-1. Potential TWA Deliveries along the San José GWR Alignment

Delivery Point		Reuse Type	Potential TWA and GWR Deliveries (mgd)					
			Normal Year			Dry Year		
			Min	Avg	Max	Min	Avg	Max
1	VW – LGRP system	GWR	6	7	10	3	3	10
2	San José Muni – Nortech	TWA	1	1.5	3	1.5	2	3
3	San José Muni – Tasman	TWA	0	0.5	1	0	1	2
4	Santa Clara – Northside	TWA	1.5	2.5	3.5	2	3.5	4.5
5	SJW – Campbell	TWA	1.5	2	2.5	1.5	2	2.5
10	Santa Clara – Jenny Strand Park	TWA	2	3.5	5	3	4.5	6
11	VW – Treated Water Lateral	TWA	3	7	11.5	4	8	11.5
		Total	24			24		

A.2 San José Municipal Water

Within the SJ Muni service area, purified water could be used to improve water supply reliability by supplementing potable water supplies during dry years, particularly when San Francisco Public Utilities Commission (SFPUC) water supply is reduced, and to support increased future water demands in the northern portion of San José.

The proposed San José GWR pipeline crosses through the SJ Muni service area north of Highway 237, though SFPUC turnouts are located south of the highway. Delivery points both north and south of Highway 237 to SJ Muni were identified to maximize the opportunity to deliver purified water for TWA, including the following.

- **Nortech Parkway Tank.** At the existing eastern terminus of Nortech Parkway, SJ Muni has a water storage tank. It is assumed that this tank could be supplied with 1.5 mgd of purified water during normal years, increasing to 2 mgd during dry years. Seasonally, peak month deliveries could increase to 3 mgd.
- **Tasman Avenue.** The pipeline supplying the Nortech Parkway Tank would continue south across Highway 237 and supply purified water for TWA to an area near SJ Muni's existing SFPUC turnouts, just south of Tasman Drive. Because there would be no mixing or large vessel to receive water, it is assumed that between 0.5 and 1 mgd of purified water could be delivered in normal years with a maximum of 2 mgd in dry years.

A.3 City of Santa Clara

Santa Clara is the second largest water retailer in the Santa Clara County (County). Purified water would be used to improve water supply reliability in the portion of their service area that receives SFPUC supply, as well as to reduce groundwater pumping and offset treated water supplies from VW. Additionally, purified water would be used during dry years when imported and/or SFPUC water supply may be reduced.

The San José GWR alignment crosses through much of Santa Clara. To maximize the reach of purified water deliveries, purified water turnouts would extend to locations where Santa Clara receives water from either SFPUC or VW. The proposed delivery points follow.

- **Northside Tanks.** Santa Clara has an SFPUC turnout at this location along with local storage, the Northside Tanks, that hold supply purchased from the SFPUC. To supplement the supply in this area with TWA, a purified water pipeline would extend from Lafayette Avenue across the Levi's Stadium parking lot and Guadalupe River to fill the Northside Tanks. Deliveries are assumed to be 2.5 mgd during normal years, increasing to 3.5 mgd during dry years. Seasonally, peak month deliveries could increase to 4.5 mgd.
- **Jenny Strand Park Tanks.** Santa Clara has three water storage tanks and a VW turnout at this location. Purified water would be delivered to both the water storage tanks and the VW treated water pipelines for use in the VW wholesale service area of Santa Clara's distribution system. With the size and scale of the water infrastructure at this location, it is assumed that an average of 3.5 mgd and a peak of 6 mgd of purified water could be delivered to Santa Clara at this point. In addition to local demands, VW could deliver purified water to other turnouts through their existing treated water pipeline. To accomplish this, the proposed purified water pipeline would be connected directly into the VW treated water pipeline. Flow into the purified water pipeline would be reversed, and VW could deliver purified water to other turnouts within their treated water distribution system. It was assumed that an average of 7 mgd would be conveyed in this manner, peaking to 11.5 mgd during peak month or dry years.

A.4 San Jose Water

The SJW service area receives supply from many sources, including treated water and groundwater. Purified water deliveries to SJW would reduce groundwater pumping and treated water deliveries and help increase overall water system reliability within the County.

A VW treated water pipeline currently delivers supply to SJW at the Campbell location. With current supply amount and diverse sources, it was assumed that SJW would not require significantly more purified water during higher demand months or dry years. TWA deliveries are assumed to be 2 mgd during both normal and dry years and increasing to 2.5 mgd during dry years.

Purified water for TWA could also be delivered to the VW treated water pipeline, like the concept outlined for the Jenny Strand Park delivery point. However, it is assumed that most of the purified water delivered to the VW treated water pipeline would convey through Jenny Strand Park, since the pipeline capacity is higher at that location.

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Attachment B: San José Flex Scenario Cost Estimates

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Table B-1. Overview of Capital and Annual O&M Costs for San José Flex Scenarios

									Purified water yield (AFY)		Near-term project (10 mgd) costs ($M)				Expansion (+14 mgd) costs ($M)				Buildout (24 mgd) total costs ($M)	
Table no. in CoRe Plan Appendix A-6	**Table no. in San José Flex TM, Attachment B**	**ID no.**	**Project element**	**Location or start point**	**End point**	**Diameter (in)**	**Length (LF)**	**Length (miles)**	**Lower bound[a]**	**Upper bound[a]**	**Capital**	**Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**	**Capital**	**Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**
San José GWR Flex Scenario																				
–	Table B-2	AWPF	AWPF - GWR Flex	San José	–	–	–	–	–	–	$ 206	$ 5.9	$ 210	$ 5.9	$ 145	$ 8	$ 145	$ 7.5	$ 355	$ 13.4
Table 3	–	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	2,000	0.4	–	–	$ 6	$ 0.003	$ 235	$ 1.8	$ -	$ -	$ 15	$ 1.8	$ 250	$ 3.6
–	Table B-5	PL-2-Alt	Purified Water Pipeline	San José AWPF	LGRP	36	95,490	18.1	–	–	$ 188	$ 0.2			$ -	$ -				
–	Table B-12/13	PS-1	Pump Station	San José AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.1			$ 12	$ 1.7				
Table 6	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	97,490	18.5	–	–	$ 3	$ -			$ -	$ -				
–	–	ROCM-1a	ROCM strategy	–	–	–	–	–	–	–	$ 19	$ 0.7	$ 20	$ 0.8	$ -	$ 1.0	$ -	$ 1.1	$ 20	$ 1.9
–	–	Source water	Purchased supply for reuse[b]	SJ/SC RWF	–	–	–	–	19,000	24,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.4	$ -	$ 1.4	$ -	$ 2.4
TOTAL - Excluding ROCM													$ 445	$ 8.7			$ 160	$ 10.7	$ 605	$ 19.4
TOTAL													**$ 465**	**$ 9.5**			**$ 160**	**$ 11.8**	**$ 625**	**$ 21.3**
San José RWA Flex Scenario																				
–	Table B-3	AWPF	AWPF	San José	–	–	–	–	–	–	$ 206	$ 6	$ 210	$ 6.1	$ 187	$ 9.7	$ 190	$ 9.8	$ 400	$ 15.9
Table 3	–	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	2,000	0.4	–	–	$ 6	$ 0.003	$ 235	$ 1.8	$ -	$ -	$ 55	$ 3.8	$ 290	$ 5.6
–	Table B-5	PL-2-Alt	Purified Water Pipeline	San José AWPF	LGRP	36	95,490	18.1	–	–	$ 188	$ 0.2			$ -	$ -				
–	Table B-6	Rinconada Extension PL	Purified Water Pipeline	LGRP	Rinconada WTP	36	12,400	2.3	–	–	$ -	$ -			$ 24	$ 0.02				
–	Table B-12/13	PS-1	Pump Station	San José AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.1			$ 12	$ 1.7				
–	Table B-11	Rinconada RWA Booster PS	Pump Station	LGRP	Rinconada WTP	–	–	–	–	–	$ -	$ -			$ 18	$ 2.0				
Table 6	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	97,490	18.5	–	–	$ 3	$ -			$ 0.1	$ -				
–	–	ROCM-1a	ROCM strategy	–	–	–	–	–	–	–	$ 19	$ 0.7	$ 20	$ 0.8	$ -	$ 1.0	$ -	$ 1.1	$ 20	$ 1.9
–	–	Source water	Purchased supply for reuse[b]	SJ/SC RWF	–	–	–	–	19,000	24,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.4	$ -	$ 1.4	$ -	$ 2.4
TOTAL - Excluding ROCM													$ 445	$ 8.9			$ 245	$ 15.0	$ 690	$ 23.9
TOTAL													**$ 465**	**$ 9.7**			**$ 245**	**$ 16.1**	**$ 710**	**$ 25.8**
San José TWA Flex Scenario																				
–	Table B-4	AWPF	AWPF	San José	–	–	–	–	–	–	$ 213	$ 6.0	$ 215	$ 6.1	$ 194	$ 10.1	$ 195	$ 10.1	$ 410	$ 16.2
Table 3	–	PL-1	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	2,000	0.4	–	–	$ 6	$ 0.003	$ 235	$ 1.8	$ -	$ -	$ 50	$ 1.9	$ 285	$ 3.7
–	Table B-5	PL-2-Alt	Purified Water Pipeline	San José AWPF	LGRP	36	95,490	18.1	–	–	$ 188	$ 0.2			$ -	$ -				
–	Table B-7	DP-2/3 PL	Purified Water Pipeline	PL-2-Alt Junction	San Jose Municipal Water - Nortech/Tasman	16	13,200	2.5	–	–	$ -	$ -			$ 10	$ 0.03				
–	Table B-8	DP-4 PL	Purified Water Pipeline	PL-2-Alt Junction	Santa Clara - Northside	12	2,600	0.5	–	–	$ -	$ -			$ 2	$ 0.01				
–	Table B-9	DP-5	Purified Water Pipeline	PL-2-Alt Junction	SJW - Campbell	16	1,600	0.3	–	–	$ -	$ -			$ 1	$ 0.01				
–	Table B-10	DP-10/11 PL	Purified Water Pipeline	PL-2-Alt Junction	Santa Clara - Jenny Strand Park/VW Treated Water PL	30	11,200	2.1	–	–	$ -	$ -			$ 19	$ 0.02				
–	Table B-12/13	PS-1	Pump Station	San José AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.1			$ 12	$ 1.7				
Table 6	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	126,090	23.9	–	–	$ 3	$ -			$ 1	$ -				
–	–	ROCM-1a	ROCM strategy	–	–	–	–	–	–	–	$ 19	$ 0.7	$ 20	$ 0.8	$ -	$ 1.0	$ -	$ 1.1	$ 20	$ 1.9
–	–	Source water	Purchased supply for reuse[b]	SJ/SC RWF	–	–	–	–	19,000	24,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.4	$ -	$ 1.4	$ -	$ 2.4
TOTAL - Excluding ROCM													$ 450	$ 8.9			$ 245	$ 13.4	$ 695	$ 22.3
TOTAL													**$ 470**	**$ 9.7**			**$ 245**	**$ 14.5**	**$ 715**	**$ 24.2**

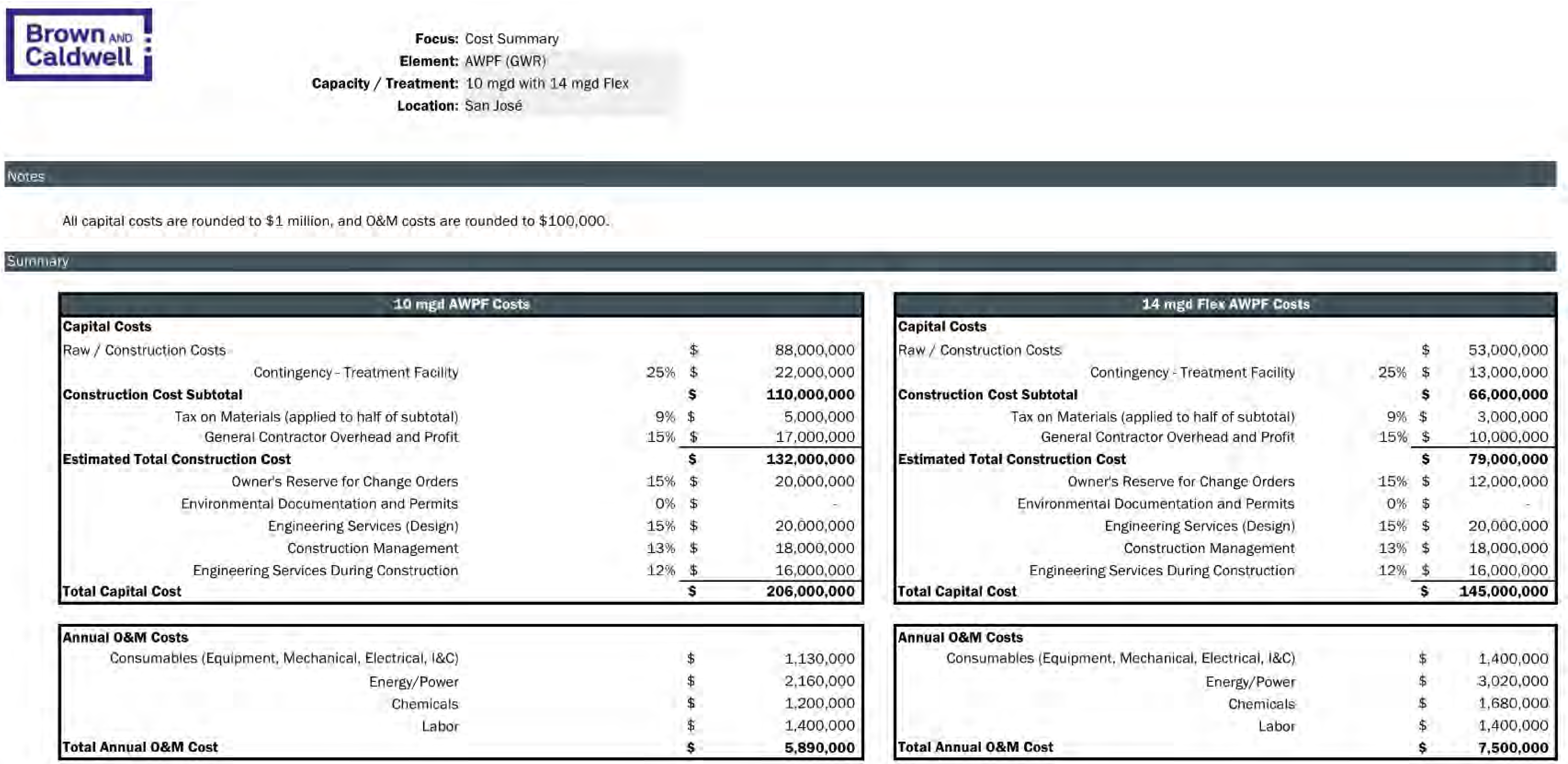
a. Upper bound of yield is assumed in facility sizing for cost estimates and for the purposes of calculating source water costs. Lower bound reflects potential source water availability limitations or delivery point limitations (e.g., groundwater basin capacity). See Appendix A-2 for additional information on flow assumptions.

b. Assumes unit cost of source water purchased as supply for all scenarios is $100/AF.

c. Assumes that pipeline easement cost is $32/foot for all pipelines.

d. All costs reported in July 2019 dollars.

Table B-2. Cost Estimate Details: San José AWPF for GWR Flex



Focus: Cost Summary
Element: AWPF (GWR)
Capacity / Treatment: 10 mgd with 14 mgd Flex
Location: San José

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	88,000,000
Contingency - Treatment Facility	25%	$	22,000,000
Construction Cost Subtotal		**$**	**110,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	17,000,000
Estimated Total Construction Cost		**$**	**132,000,000**
Owner's Reserve for Change Orders	15%	$	20,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	20,000,000
Construction Management	13%	$	18,000,000
Engineering Services During Construction	12%	$	16,000,000
Total Capital Cost		**$**	**206,000,000**
Annual O&M Costs			
Consumables (Equipment, Mechanical, Electrical, I&C)		$	1,130,000
Energy/Power		$	2,160,000
Chemicals		$	1,200,000
Labor		$	1,400,000
Total Annual O&M Cost		**$**	**5,890,000**

14 mgd Flex AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	53,000,000
Contingency - Treatment Facility	25%	$	13,000,000
Construction Cost Subtotal		**$**	**66,000,000**
Tax on Materials (applied to half of subtotal)	9%	$	3,000,000
General Contractor Overhead and Profit	15%	$	10,000,000
Estimated Total Construction Cost		**$**	**79,000,000**
Owner's Reserve for Change Orders	15%	$	12,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	20,000,000
Construction Management	13%	$	18,000,000
Engineering Services During Construction	12%	$	16,000,000
Total Capital Cost		**$**	**145,000,000**
Annual O&M Costs			
Consumables (Equipment, Mechanical, Electrical, I&C)		$	1,400,000
Energy/Power		$	3,020,000
Chemicals		$	1,680,000
Labor		$	1,400,000
Total Annual O&M Cost		**$**	**7,500,000**

10 mgd AWPF Costs

Construction Costs by Division	Cost Summary	% of Total Cost
Division 01 – General Requirements	$ 7,993,800	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 6,116,900	7%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	0%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,427,600	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,710,400	11%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 5,224,000	6%
Division 32 – Exterior Improvements	$ 155,300	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,867,200	10%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 21,005,300	24%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,701,300	29%
TOTAL	**$ 88,000,000**	

14 mgd Flex AWPF Costs

Construction Costs by Division	Cost Summary	% of Total Cost
Division 01 – General Requirements	$ 4,811,720	5%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ -	0%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 437,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 1,948,410	2%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 7,793,642	9%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,962,688	10%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 2,412,820	3%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,978,806	30%
TOTAL	**$ 53,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **10 mgd with 14 mgd Flex**
Location: **San José**

Date: 12/4/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Prepared by: R. Gullen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 79,937,200	10% of Divisions 2-47	$ 7,993,800		$ 4,811,720	10% of Divisions 2-47
Division 31 – Earthwork		Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200		$ -	
Division 31 – Earthwork		Strip Topsoil		37,534	SY		$ 0.85			$ 32,000		$ -	
Division 31 – Earthwork		Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400		$ -	
Division 31 – Earthwork		Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here	$ -	
Division 31 – Earthwork		Excavation		19,448	CY		$ 11.78			$ 229,100		$	
Division 31 – Earthwork		Compaction		18,767	CY		$ 0.89			$ 16,800		$ -	
Division 31 – Earthwork		Grading		37,534	SY		$ 1.18			$ 44,300		$ -	
Division 31 – Earthwork		Shoring, Sheeting, and Bracing		0.25	LS			$ 25,000		$ 6,300		$ -	
Division 31 – Earthwork		Offhaul Allowance		0.02	LS			$ 75,000	Engineer's Estimate	$ 1,500		$ -	
Division 31 – Earthwork	Sitework	Aggregate Base		12,711	CY		$ 58.49			$ 743,500		$ -	
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800		$ -	
Division 31 – Earthwork	Sitework	Gravel		7,911	SY		$ 4.63			$ 36,700		$ -	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000		$ -	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800		$	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800		$ -	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000		$ -	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000		$ -	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank	$ -	
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure	$ -	
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure	$ -	
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure	$ -	
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		162	CY		$ 645		See Site Work and Concrete Tab	$ 104,700	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage	$ -	
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage	$	
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building	$ -	
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical	$ -	
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical	$ -	
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station	$ -	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 52.94			$ 155,300		$ -	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 312,500	Engineer's Estimate	$ 312,500	Scaled down from the 24 MGD facility	$ 437,500	
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 416,667	Engineer's Estimate	$ 416,700	Scaled down from the 24 MGD facility	$ 583,333	

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Estimate Version Number: 2.0
Prepared by: R. Guillen
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	ea	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Scaled down from the 10.5 MGD facility	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000		$	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,786				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,042,900	Scaled down from the 10.5 MGD facility	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			Scaled down from the proposal from Daniel Mechanical that included (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			1 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP, scaled costs down from 24 mgd AWPF based on assumption of only needing two (2) 12 mgd (1 duty and 1 standby) reactors.	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps		4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements	$	
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 219		245' x 345'; furnished and installed	$ 18,475,300	Process Building	$ -	
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	2	0.5	EA	$ 3,650,000			Scaled back from DN Tanks cost proposal for 4 MG tank, need one 2 MG tank for 10 mgd	$ 1,825,000	Prestressed Concrete Tank	$ 1,825,000	Need an additional 2 MG tank for 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)	$	

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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz. Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 7,793,642	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 389,682	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 389,682	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 389,682	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 7,793,642	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$9,710,400	25% of Electrical Costs	$ 2,427,600		$ 1,948,410	25% of Electrical Costs
O&M	Consumables	UF Membranes Replacement		338	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	RO Membranes Replacement		385	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 133,700	installation costs must be covered by O&M labor	$ 187,101	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	installation costs must be covered by O&M labor	$ 48,067	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor	$ 26,679	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,402,300	2% of Pumping Equipment Cost	$ 28,100		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,710,400	2% of Electrical Cost	$ 194,300		$ 155,873	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,427,600	2% of Instrumentation & Controls Cost	$ 48,600		$ 38,968	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 500		$ 619	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 600		$ 809	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Feed Pumps		12,253,050	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 1,267,700		$ 1,774,659	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Inter Stage Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 200		$ 143	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF

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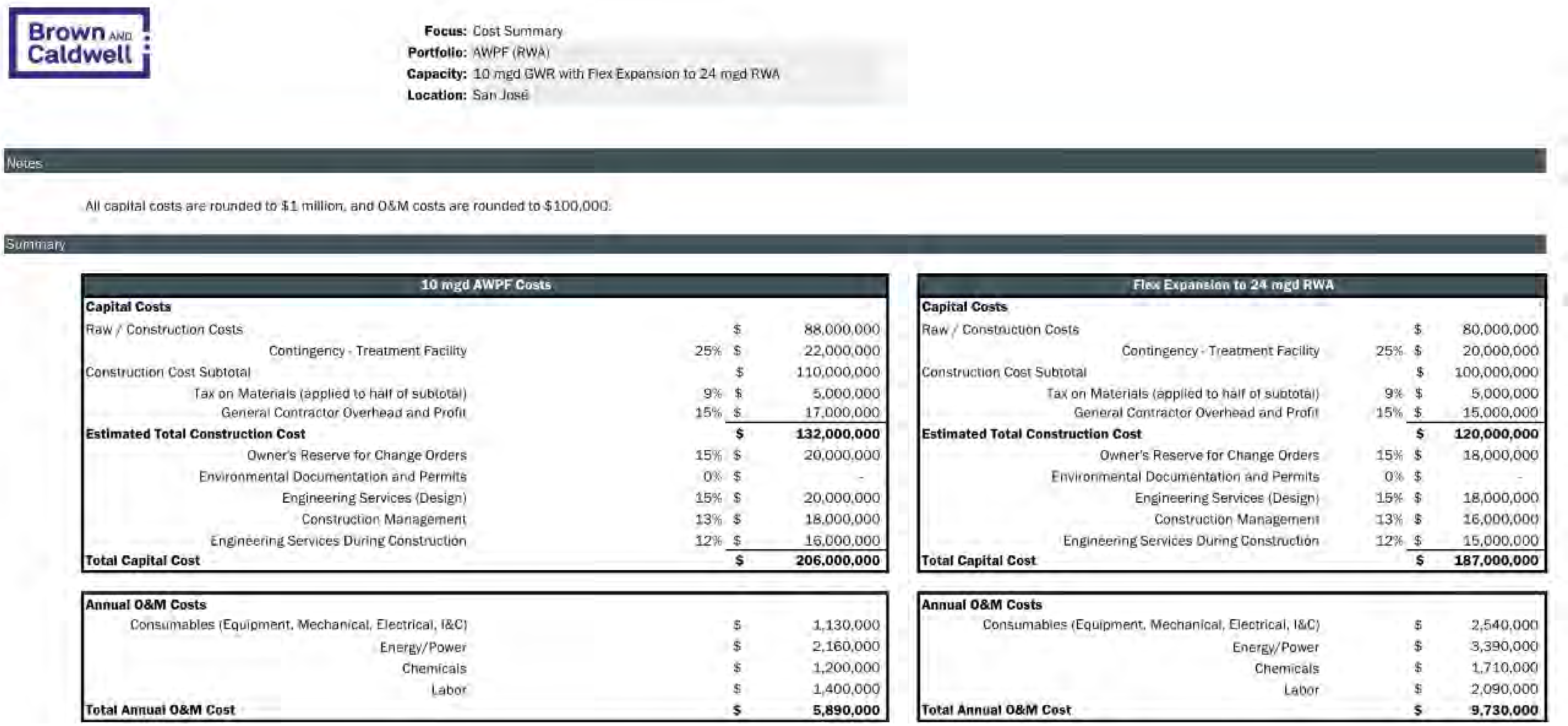
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 22,600		$ 31,549	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 56,400		$ 78,874	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 188,900		$ 264,322	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		735,183	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 76,100		$ 106,480	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Waste Equalization Pumps		326,748	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 33,900		$ 47,324	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 2,000		$ 2,761	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 48,400		$ 67,713	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 1,300		$ 1,761	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 8,400		$ 11,697	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 128,500		$ 179,812	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 115,400		$ 161,444	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 537,400		$ 752,236	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Lime		365,511	lb		$ 0.15		based on 12 mg/L dose	$ 54,800		$ 76,684	based on 12 mg/L dose
O&M	Chemicals	Sulfuric Acid		11,200	gal		$ 1.00		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 11,200		$ 15,650	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Antiscalant		11,000	gal		$ 20.56		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 226,300		$ 316,688	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Low pH Cleaner		8,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 47,400		$ 66,283	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO High pH Cleaner		8,500	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 24,600		$ 34,307	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Labor	Water Plant Operator		2080	hours/yr		$ 163.20			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)	$ 679,000	Assumes two additional plant operators 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Sr Mechanics		2080	hours/yr		$ 172.27			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF (GWR)**
Capacity:	**10 mgd with 14 mgd Flex**
Location:	**San José**

Date:	12/4/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Prepared by:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
O&M	Labor	Control Tech II		2080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)	$	

Table B-3. Cost Estimate Details: San José AWPF for RWA Flex



Focus: Cost Summary
Portfolio: AWPF (RWA)
Capacity: 10 mgd GWR with Flex Expansion to 24 mgd RWA
Location: San José

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	88,000,000
Contingency - Treatment Facility	25%	$	22,000,000
Construction Cost Subtotal		$	110,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	17,000,000
Estimated Total Construction Cost		**$**	**132,000,000**
Owner's Reserve for Change Orders	15%	$	20,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	20,000,000
Construction Management	13%	$	18,000,000
Engineering Services During Construction	12%	$	16,000,000
Total Capital Cost		**$**	**206,000,000**

Flex Expansion to 24 mgd RWA			
Capital Costs			
Raw / Construction Costs		$	80,000,000
Contingency - Treatment Facility	25%	$	20,000,000
Construction Cost Subtotal		$	100,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	15,000,000
Estimated Total Construction Cost		**$**	**120,000,000**
Owner's Reserve for Change Orders	15%	$	18,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	18,000,000
Construction Management	13%	$	16,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**187,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,130,000
Energy/Power	$	2,160,000
Chemicals	$	1,200,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**5,890,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,540,000
Energy/Power	$	3,390,000
Chemicals	$	1,710,000
Labor	$	2,090,000
Total Annual O&M Cost	**$**	**9,730,000**

10 mgd AWPF Costs

Construction Costs by Division	Cost Summary	% of Total Cost
Division 01 – General Requirements	$ 7,999,500	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 6,171,500	7%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	0%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,427,600	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,710,400	11%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 5,227,000	6%
Division 32 – Exterior Improvements	$ 155,300	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,867,200	10%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 21,005,300	24%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,701,300	29%
TOTAL	**$ 88,000,000**	

Flex Expansion to 24 mgd RWA

Construction Costs by Division	Cost Summary	% of Total Cost
Division 01 – General Requirements	$ 7,234,607	8%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 1,529,000	2%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 437,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,938,230	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 11,752,922	13%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 13,515,860	15%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 2,412,820	3%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 39,176,406	45%
TOTAL	**$ 80,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd RWA**
Location: **San José**

Date: 12/21/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$79,994,800	10% of Divisions 2-47	$ 7,999,500		$ 7,234,607	10% of Divisions 2-47
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200			
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000			
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400			
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here		
Division 31 – Earthwork	Sitework	Excavation		19,682	CY		$ 11.78			$ 231,900			
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800			
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300			
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300			
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500			
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100			
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800			
Division 31 – Earthwork	Sitework	Gravel		7,611	SY		$ 4.63			$ 35,300			
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000			
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800			
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800			
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000			
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000			
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank		
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure		
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure		
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure		
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 119,500	Added as part of RWA expansion
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 56,800	Added as part of RWA expansion
Division 03 – Concrete	Concrete	Ozone Contactors Slab		213	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 137,600	Added as part of RWA expansion
Division 03 – Concrete	Concrete	Ozone Contactor Walls		594	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 647,300	Added as part of RWA expansion
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	BAC Filter Slab		373	CY		$ 645		See Site Work and Concrete Tab	$ -	BAC	$ 240,800	Added as part of RWA expansion
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ -	BAC	$ 327,000	Added as part of RWA expansion
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment		
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage		
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage		
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building		
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical		
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station		

Brown AND Caldwell

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd RWA**
Location: **San José**

Date: 12/21/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station		
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300			
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$312,500	Engineer's Estimate	$ 312,500	Scaled down from the 24 MGD facility	$ 437,500	
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$416,667	Engineer's Estimate	$ 416,700	Scaled down from the 24 MGD facility	$ 583,333	
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco	$ -		$ 7,455,900	Added as part of RWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ -		$ 5,741,700	Added as part of RWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	EA	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Scaled down from the 10.5 MGD facility	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000			
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,786				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,042,900	Scaled down from the 10.5 MGD facility	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System		
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements		

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd RWA**
Location: **San José**

Date: 12/21/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375.00		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	2	0.5	EA	$ 3,650,000			Scaled back from DN Tanks cost proposal for 4 MG tank, need one 2 MG tank for 10 mgd	$ 1,825,000	Prestressed Concrete Tank	$ 1,825,000	Need an additional 2 MG tank for 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 11,752,922	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 11,752,922	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$9,710,400	25% of Electrical Costs	$ 2,427,600		$ 2,938,230	25% of Electrical Costs
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ -		$ 1,046,200	Added as part of RWA expansion
O&M	Consumables	UF Membranes Replacement		338	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	RO Membranes Replacement		385	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 133,700	Installation costs must be covered by O&M labor	$ 187,101	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	Installation costs must be covered by O&M labor	$ 48,067	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	Installation costs must be covered by O&M labor	$ 26,679	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,402,300	2% of Pumping Equipment Cost	$ 28,100		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,710,400	2% of Electrical Cost	$ 194,300		$ 235,058	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,427,600	2% of Instrumentation & Controls Cost	$ 48,600		$ 58,765	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ -		$ 290,800	Added as part of RWA expansion

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF (RWA)**
Capacity:	**10 mgd GWR with Flex Expansion to 24 mgd RWA**
Location:	**San José**

Date:	12/21/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Engineer:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ -		$ 14,900	Added as part of RWA expansion
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ -		$ 21,800	Added as part of RWA expansion
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ -		$ 30,500	Added as part of RWA expansion
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ -		$ 11,900	Added as part of RWA expansion
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ -		$ 4,000	Added as part of RWA expansion
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 500		$ 619	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 600		$ 809	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Feed Pumps		13,614,500	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 1,408,500		$ 1,774,659	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Inter-Stage Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 200		$ 143	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 22,600		$ 31,549	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 56,400		$ 78,874	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 188,900		$ 264,322	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		735,183	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 76,100		$ 106,480	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Waste Equalization Pumps		326,748	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 33,900		$ 47,324	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 2,000		$ 2,761	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ -		$ 21,100	Added as part of RWA expansion
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 48,400		$ 67,713	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 1,300		$ 1,761	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 8,400		$ 11,697	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 128,500		$ 179,812	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 115,400		$ 161,444	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 537,400		$ 752,236	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Lime		365,511	lb		$ 0.15		based on 12 mg/L dose	$ 54,800		$ 76,684	based on 12 mg/L dose

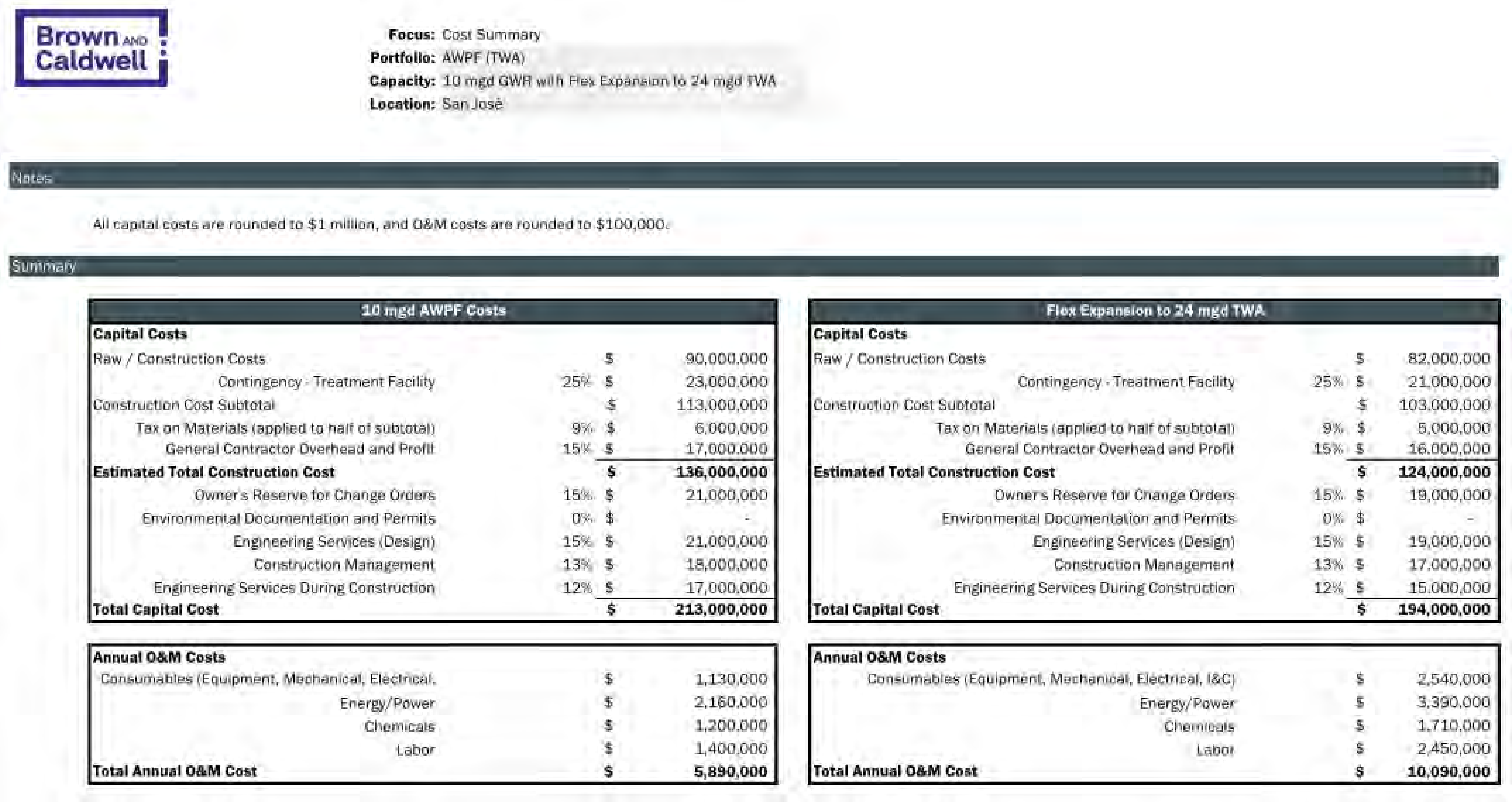
Brown AND Caldwell

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (RWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd RWA**
Location: **San José**

Date: 12/21/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
O&M	Chemicals	Sulfuric Acid		11,200	gal		$ 1.00		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 11,200		$ 15,650	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Antiscalant		11,000	gal		$ 20.56		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 226,300		$ 316,688	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Low pH Cleaner		8,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 47,400		$ 66,283	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO High pH Cleaner		8,500	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 24,600		$ 34,307	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Labor	Water Plant Operator		2,080	hours/yr		$ 163.20			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)	$ 1,018,500	Assumes three additional plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)	$ 716,800	Assumes two additional senior mechanic 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)		

Table B-4. Cost Estimate Details: San José AWPF for TWA Flex



Focus: Cost Summary
Portfolio: AWPF (TWA)
Capacity: 10 mgd GWR with Flex Expansion to 24 mgd TWA
Location: San José

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	90,000,000
Contingency - Treatment Facility	25%	$	23,000,000
Construction Cost Subtotal		$	113,000,000
Tax on Materials (applied to half of subtotal)	9%	$	6,000,000
General Contractor Overhead and Profit	15%	$	17,000,000
Estimated Total Construction Cost		**$**	**136,000,000**
Owner's Reserve for Change Orders	15%	$	21,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	21,000,000
Construction Management	13%	$	18,000,000
Engineering Services During Construction	12%	$	17,000,000
Total Capital Cost		**$**	**213,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical,	$	1,130,000
Energy/Power	$	2,160,000
Chemicals	$	1,200,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**5,890,000**

Flex Expansion to 24 mgd TWA			
Capital Costs			
Raw / Construction Costs		$	82,000,000
Contingency - Treatment Facility	25%	$	21,000,000
Construction Cost Subtotal		$	103,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**124,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	17,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**194,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,540,000
Energy/Power	$	3,390,000
Chemicals	$	1,710,000
Labor	$	2,450,000
Total Annual O&M Cost	**$**	**10,090,000**

10 mgd AWPF Costs		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 8,184,400	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 6,171,500	7%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	0%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,427,600	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,710,400	11%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 5,250,300	6%
Division 32 – Exterior Improvements	$ 155,300	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,867,200	10%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 22,830,300	25%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,701,300	29%
TOTAL	**$ 90,000,000**	

Flex Expansion to 24 mgd TWA		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,498,547	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 2,343,400	3%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 437,500	1%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,938,230	4%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 11,752,922	14%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 13,515,860	16%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 4,237,820	5%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 39,176,406	48%
TOTAL	**$ 82,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location: **San José**

Date: 12/21/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
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Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$81,843,100	10% of Divisions 2-47	$ 8,184,400		$ 7,498,547	10% of Divisions 2-47
Division 31 – Earthwork	Sitework	Site Clear and Grub		7.76	Acre		$ 7,760			$ 60,200			
Division 31 – Earthwork	Sitework	Strip Topsoil		37,534	SY		$ 0.85			$ 32,000			
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		37,534	CY		$ 8.88			$ 333,400			
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		37,534	CY		$ 1.04			$ 39,100	This seems low, but used means est for structural backfill here		
Division 31 – Earthwork	Sitework	Excavation		22,423	CY		$ 11.78			$ 264,200			
Division 31 – Earthwork	Sitework	Compaction		18,767	CY		$ 0.89			$ 16,800			
Division 31 – Earthwork	Sitework	Grading		37,534	SY		$ 1.18			$ 44,300			
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300			
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500			
Division 31 – Earthwork	Sitework	Aggregate Base		12,738	CY		$ 58.49			$ 745,100			
Division 31 – Earthwork	Sitework	Asphalt		1,864	SF		$ 2.01			$ 3,800			
Division 31 – Earthwork	Sitework	Gravel		5,666	SY		$ 4.63			$ 26,300			
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000			
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 168,768		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 168,800			
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 1,010,756			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 1,010,800			
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000			
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineer's Estimate	$ 2,000,000			
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141		Assumes (2) 40' diameter slabs: Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank		
Division 31 – Earthwork	Sitework	24-inch Waste Pipeline		2,925	LF		$ 491		24-inch, MLCSP, 11' Cover	$ 1,434,900	plant infrastructure		
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 1,434,900	9' to 14' of cover	$ 71,800	plant infrastructure		
Division 31 – Earthwork	Sitework	Potholing		29	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 36,100	plant infrastructure		
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 119,500	Added as part of TWA expansion
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 56,800	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 206,400	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 627,900	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Influent Wetwell Slab		277	CY		$ 645		See Site Work and Concrete Tab	$ 178,600	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Influent Wetwell Suspended Slab		138	CY		$ 1,150		See Site Work and Concrete Tab	$ 159,300	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Influent Wetwell Walls		291	CY		$ 1,090		See Site Work and Concrete Tab	$ 317,400	Influent Wetwell & Pump Station		
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ -	BAC	$ 275,200	Added as part of TWA expansion
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ -	BAC	$ 327,000	Added as part of TWA expansion
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment		
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 346,900	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 253,600	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 130,100	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage		
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage		
Division 03 – Concrete	Concrete	Slab for Process Building		6,261	CY		$ 645		See Site Work and Concrete Tab	$ 4,038,400	Process Building		

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BC Project Number: 151772
Estimate Version Number: 2.0
Engineer: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method A - Equipment	Cost Method B - Adjusted Unit	Cost Method C - Project-Specific	Cost Method C: Assumptions	10 mgd Near Term Cost	10 mgd Near Term Notes	+14 mgd Flex Additional Costs	+14 mgd Flex Notes
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical		
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		123	CY		$ 645		See Site Work and Concrete Tab	$ 79,100	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		181	CY		$ 1,090		See Site Work and Concrete Tab	$ 197,100	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Piping Slab		33	CY		$ 645		See Site Work and Concrete Tab	$ 21,400	Waste Equalization Wetwell & Pump Station		
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,932	LF		$ 53			$ 155,300			
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$312,500	Engineer's Estimate	$ 312,500	Scaled down from the 24 MGD facility	$ 437,500	
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$416,667	Engineer's Estimate	$ 416,700	Scaled down from the 24 MGD facility	$ 583,333	
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ -		$ 7,455,900	Added as part of TWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ -		$ 5,741,700	Added as part of TWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	EA	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Filtration Treatment	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000			
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,786				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,042,900	Filtration Treatment	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System		
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing		

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Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	40	4	EA	$ 151,800				$ 607,200	Additional Pumping Requirements		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		84,525	SF		$ 218.58		245' x 345'; furnished and installed	$ 18,475,300	Process Building		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375.00		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank for 10 mgd	$ 3,650,000	Prestressed Concrete Tanks	$ 3,650,000	Need an additional 4 MG tank for 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz. Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 11,752,922	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$7,710,400	5% of Piping Allowance	$ 385,600		$ 587,646	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$25,701,300	30% of Equipment Costs	$ 7,710,400		$ 11,752,922	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$9,710,400	25% of Electrical Costs	$ 2,427,600		$ 2,938,230	25% of Electrical Costs
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$		$ 1,046,200	Added as part of TWA expansion
O&M	Consumables	UF Membranes Replacement		338	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	RO Membranes Replacement		385	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 133,700	Installation costs must be covered by O&M labor	$ 187,101	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	Installation costs must be covered by O&M labor	$ 48,067	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF

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O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor	$ 26,679	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 1,402,300	2% of Pumping Equipment Cost	$ 28,100		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,710,400	2% of Electrical Cost	$ 194,300		$ 235,058	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,427,600	2% of Instrumentation & Controls Cost	$ 48,600		$ 58,765	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ -		$ 290,800	Added as part of TWA expansion
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ -		$ 14,900	Added as part of TWA expansion
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ -		$ 21,800	Added as part of TWA expansion
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ -		$ 30,500	Added as part of TWA expansion
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ -		$ 11,900	Added as part of TWA expansion
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ -		$ 4,000	Added as part of TWA expansion
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 500		$ 619	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 600		$ 809	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Feed Pumps		13,614,500	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 1,408,500		$ 1,774,659	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Inter-Stage Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 200		$ 143	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 22,600		$ 31,549	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 56,400		$ 78,874	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 188,900		$ 264,322	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		735,183	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 76,100		$ 106,480	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Waste Equalization Pumps		326,748	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 33,900		$ 47,324	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 2,000		$ 2,761	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ -		$ 21,100	Added as part of TWA expansion
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 48,400		$ 67,713	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 1,300		$ 1,761	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 8,400		$ 11,697	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 128,500		$ 179,812	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF

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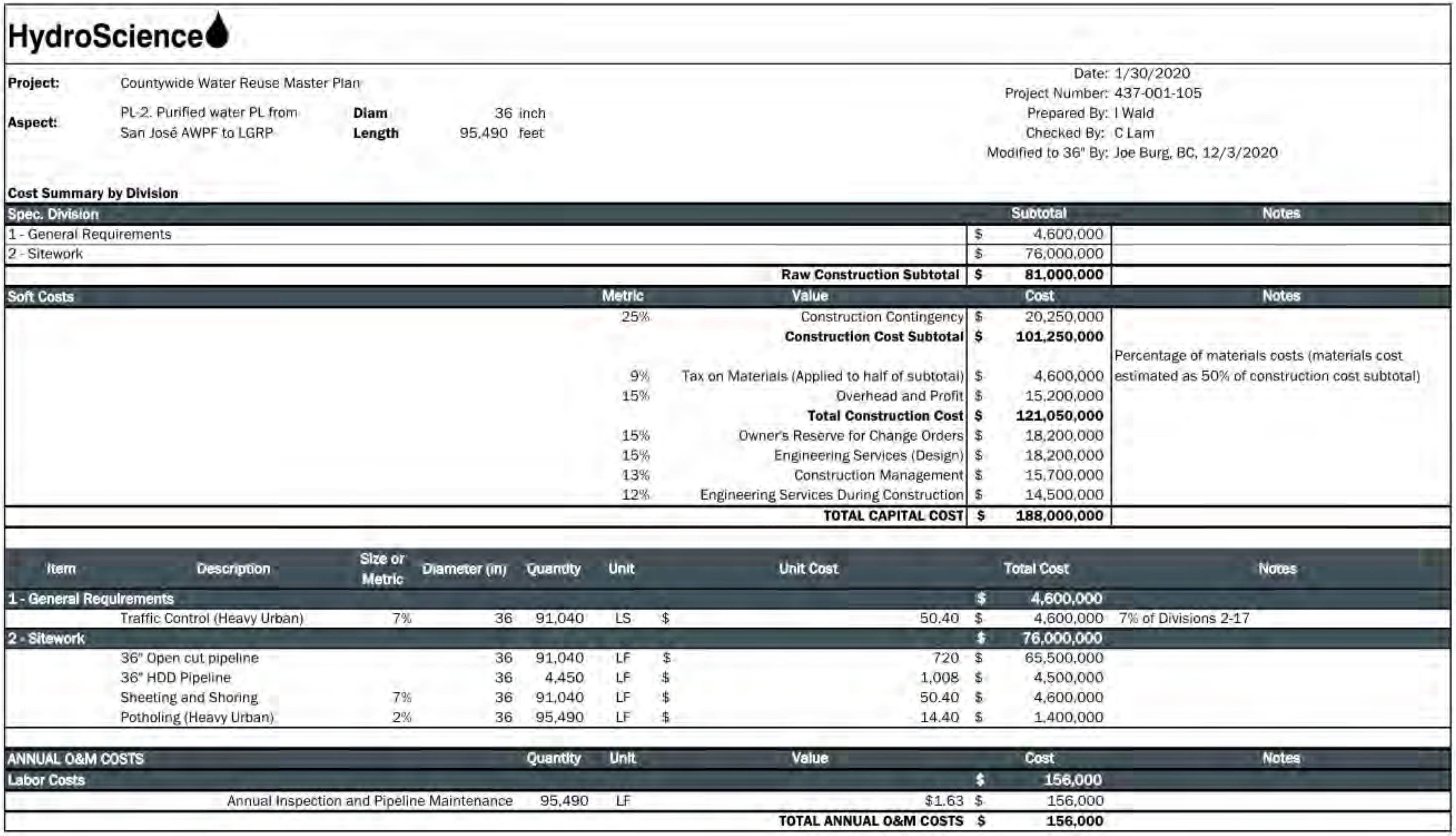
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 115,400		$ 161,444	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 537,400		$ 752,236	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Lime		365,511	lb		$ 0.15		based on 12 mg/L dose	$ 54,800		$ 76,684	based on 12 mg/L dose
O&M	Chemicals	Sulfuric Acid		11,200	gal		$ 1.00		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 11,200		$ 15,650	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Antiscalant		11,000	gal		$ 20.56		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 226,300		$ 316,688	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Low pH Cleaner		8,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 47,400		$ 66,283	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO High pH Cleaner		8,500	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 24,600		$ 34,307	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Labor	Water Plant Operator		2,080	hours/yr		$ 163.20			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)	$ 1,018,500	Assumes three additional plant operators 40 hours per week for 52 weeks in a year (3 FTE)
O&M	Labor	Sr Mechanics		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)	$ 716,800	Assumes two additional senior mechanic 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)	$ 716,800	Assumes two additional control tech 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)		

Table B-5. Cost Estimate Details: PL-2, 36-inch Purified Water Pipeline from San José AWPF to LGRP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-2. Purified water PL from San José AWPF to LGRP

Diam 36 inch
Length 95,490 feet

Date: 1/30/2020
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Modified to 36" By: Joe Burg, BC, 12/3/2020

Cost Summary by Division

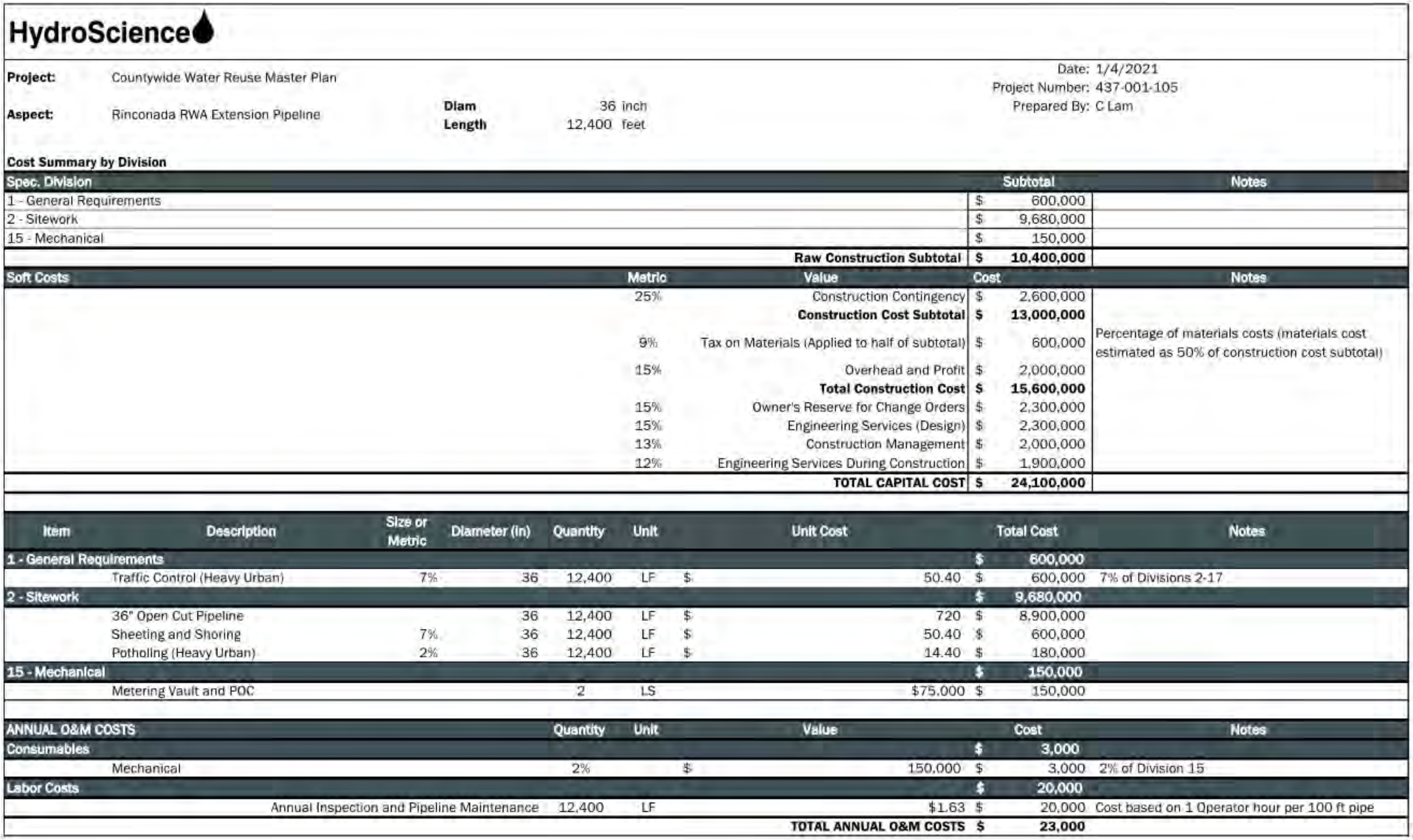
Spec. Division		Subtotal	Notes
1 - General Requirements	$	4,600,000	
2 - Sitework	$	76,000,000	
Raw Construction Subtotal	**$**	**81,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	20,250,000	
		Construction Cost Subtotal	**$**	**101,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	4,600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	15,200,000	
		Total Construction Cost	**$**	**121,050,000**	
	15%	Owner's Reserve for Change Orders	$	18,200,000	
	15%	Engineering Services (Design)	$	18,200,000	
	13%	Construction Management	$	15,700,000	
	12%	Engineering Services During Construction	$	14,500,000	
		TOTAL CAPITAL COST	**$**	**188,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**4,600,000**	
	Traffic Control (Heavy Urban)	7%	36	91,040	LS	$	50.40	$	4,600,000	7% of Divisions 2-17
2 - Sitework								**$**	**76,000,000**	
	36" Open cut pipeline		36	91,040	LF	$	720	$	65,500,000	
	36" HDD Pipeline		36	4,450	LF	$	1,008	$	4,500,000	
	Sheeting and Shoring	7%	36	91,040	LF	$	50.40	$	4,600,000	
	Potholing (Heavy Urban)	2%	36	95,490	LF	$	14.40	$	1,400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**156,000**	
Annual Inspection and Pipeline Maintenance	95,490	LF	$1.63	$	156,000	
			TOTAL ANNUAL O&M COSTS	**$**	**156,000**	

Table B-6. Cost Estimate Details: Rincondada WTP Extension, 36-inch Purified Water Pipeline from LGRP to Rinconada WTP



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: Rinconada RWA Extension Pipeline
Diam 36 inch
Length 12,400 feet

Date: 1/4/2021
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 9,680,000	
15 - Mechanical		$ 150,000	
	Raw Construction Subtotal	**$ 10,400,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,600,000	
		Construction Cost Subtotal	**$ 13,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,000,000	
		Total Construction Cost	**$ 15,600,000**	
	15%	Owner's Reserve for Change Orders	$ 2,300,000	
	15%	Engineering Services (Design)	$ 2,300,000	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,900,000	
		TOTAL CAPITAL COST	**$ 24,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	36	12,400	LF	$ 50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							**$ 9,680,000**	
	36" Open Cut Pipeline		36	12,400	LF	$ 720	$ 8,900,000	
	Sheeting and Shoring	7%	36	12,400	LF	$ 50.40	$ 600,000	
	Potholing (Heavy Urban)	2%	36	12,400	LF	$ 14.40	$ 180,000	
15 - Mechanical							**$ 150,000**	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 3,000**	
	Mechanical	2%		$ 150,000	$ 3,000	2% of Division 15
Labor Costs					**$ 20,000**	
	Annual Inspection and Pipeline Maintenance	12,400	LF	$1.63	$ 20,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 23,000**	

Table B-7. Cost Estimate Details: DP2/3, 16-inch Purified Water Pipeline from GWR Alignment to San José Muni Nortech/Tasman

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP2/3 PL - SJ Muni TWA

Diam 16 inch
Length 13,200 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

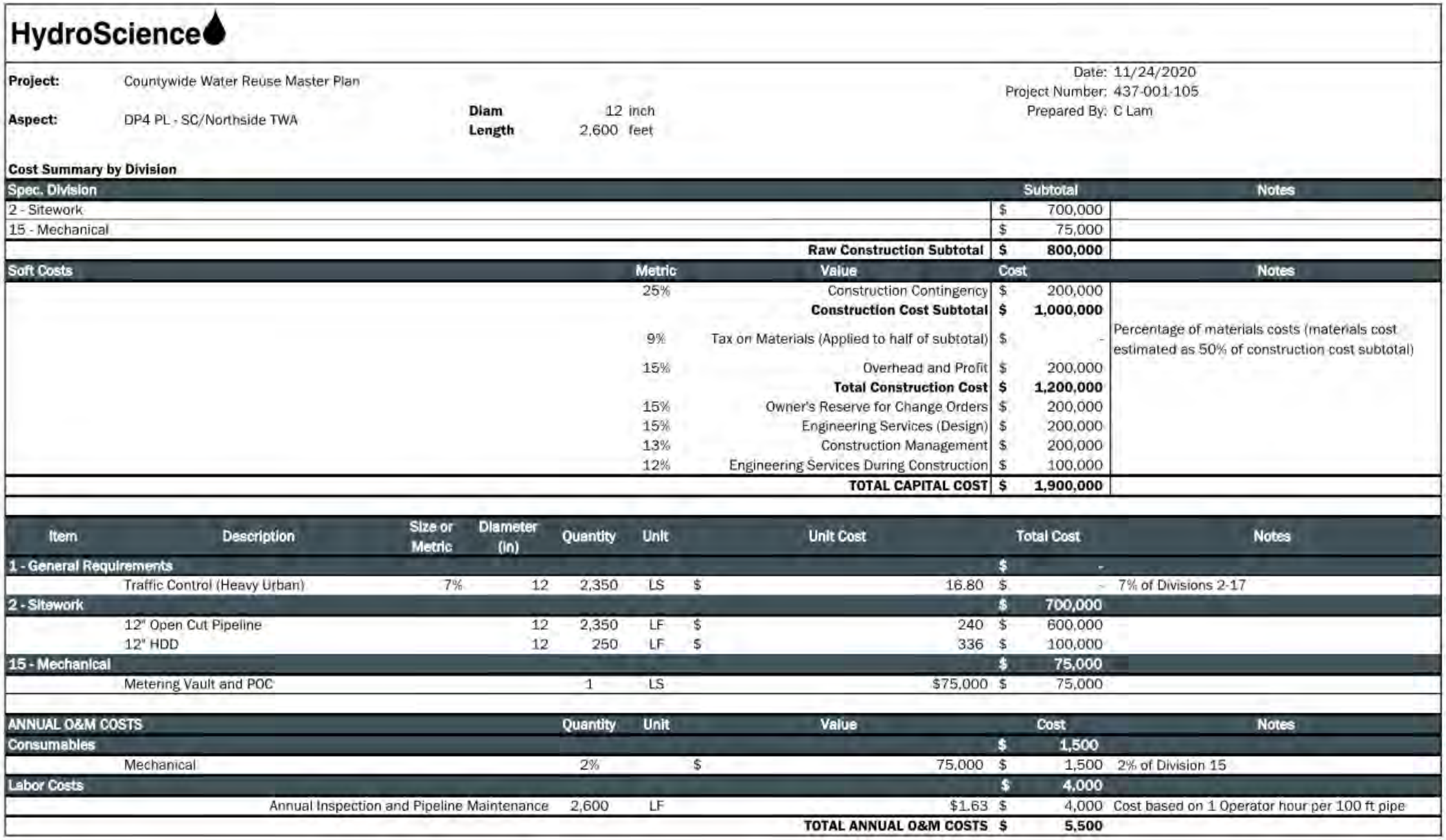
Spec. Division		Subtotal	Notes
1 - General Requirements	$	300,000	
2 - Sitework	$	3,900,000	
15 - Mechanical	$	150,000	
Raw Construction Subtotal	**$**	**4,400,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,100,000	
		Construction Cost Subtotal	**$**	**5,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	800,000	
		Total Construction Cost	**$**	**6,500,000**	
	15%	Owner's Reserve for Change Orders	$	1,000,000	
	15%	Engineering Services (Design)	$	1,000,000	
	13%	Construction Management	$	800,000	
	12%	Engineering Services During Construction	$	800,000	
		TOTAL CAPITAL COST	**$**	**10,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**300,000**	
	Traffic Control (Heavy Urban)	7%	16	12,950	LS	$ 22.40	$	300,000	7% of Divisions 2-17
2 - Sitework							**$**	**3,900,000**	
	16" Open Cut Pipeline		16	4,500	LF	$ 320	$	1,400,000	
	12" Open Cut Pipeline		12	8,450	LF	$ 240	$	2,000,000	
	12" HDD		16	250	LF	$ 448	$	100,000	
	Sheeting and Shoring	7%	16	12,950	LF	$ 22.40	$	300,000	
	Potholing (Heavy Urban)	2%	16	13,200	LF	$ 6.40	$	100,000	
15 - Mechanical							**$**	**150,000**	
	Metering Vault and POC			2	LS	$75,000	$	150,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Consumables				**$**	**3,000**	
Mechanical	0		$ 150,000	$	3,000	2% of Division 15
Labor Costs				**$**	**22,000**	
Annual Inspection and Pipeline Maintenance	13,200	LF	$1.63	$	22,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**25,000**	

Table B-8. Cost Estimate Details: DP4, 12-inch Purified Water Pipeline from GWR Alignment to Santa Clara Northside



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: DP4 PL - SC/Northside TWA
Diam 12 inch
Length 2,600 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

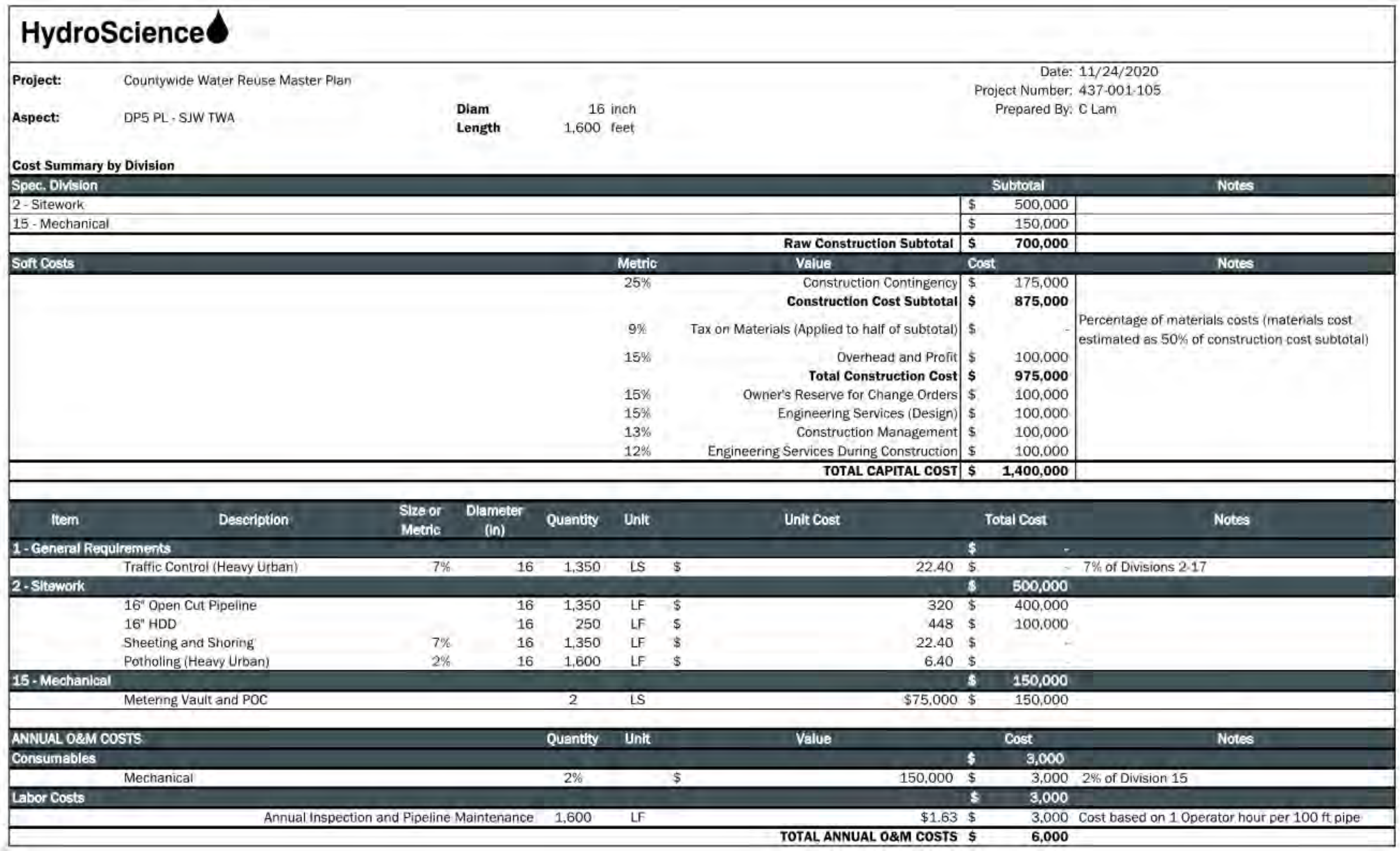
Spec. Division	Subtotal	Notes
2 - Sitework	$ 700,000	
15 - Mechanical	$ 75,000	
Raw Construction Subtotal	**$ 800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 200,000	
		Construction Cost Subtotal	**$ 1,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ -	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 200,000	
		Total Construction Cost	**$ 1,200,000**	
	15%	Owner's Reserve for Change Orders	$ 200,000	
	15%	Engineering Services (Design)	$ 200,000	
	13%	Construction Management	$ 200,000	
	12%	Engineering Services During Construction	$ 100,000	
		TOTAL CAPITAL COST	**$ 1,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ -**	
	Traffic Control (Heavy Urban)	7%	12	2,350	LS	$ 16.80	$ -	7% of Divisions 2-17
2 - Sitework							**$ 700,000**	
	12" Open Cut Pipeline		12	2,350	LF	$ 240	$ 600,000	
	12" HDD		12	250	LF	$ 336	$ 100,000	
15 - Mechanical							**$ 75,000**	
	Metering Vault and POC			1	LS	$75,000	$ 75,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 1,500**	
	Mechanical	2%		$ 75,000	$ 1,500	2% of Division 15
Labor Costs					**$ 4,000**	
	Annual Inspection and Pipeline Maintenance	2,600	LF	$1.63	$ 4,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 5,500**	

Table B-9. Cost Estimate Details: DP5, 16-inch Purified Water Pipeline from GWR Alignment to SJ Water Campbell



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	11/24/2020
				Project Number:	437-001-105
Aspect:	DP5 PL - SJW TWA	**Diam**	16 inch	Prepared By:	C Lam
		Length	1,600 feet		

Cost Summary by Division

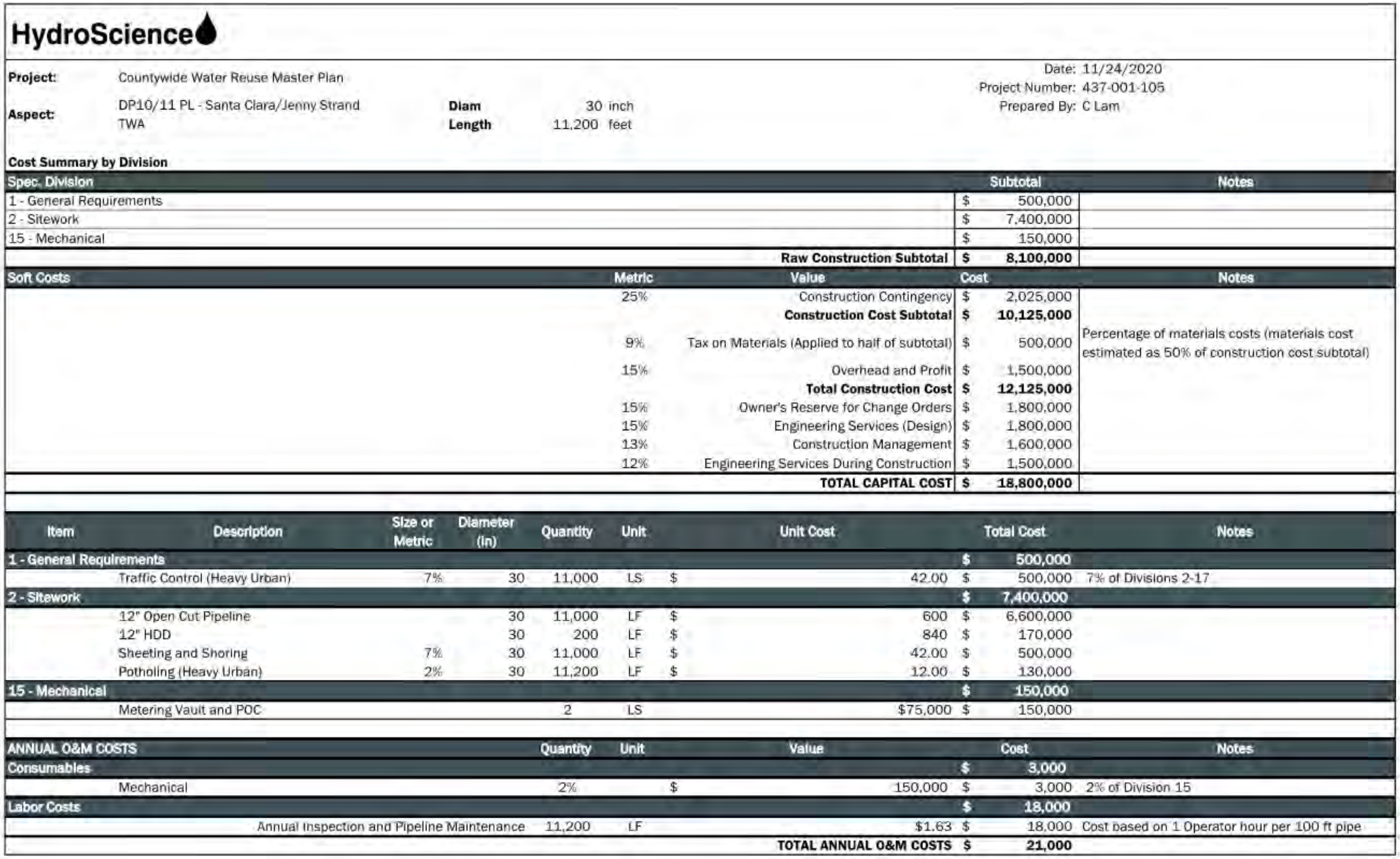
Spec. Division	Subtotal	Notes
2 - Sitework	$ 500,000	
15 - Mechanical	$ 150,000	
Raw Construction Subtotal	**$ 700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 175,000	
		Construction Cost Subtotal	**$ 875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ -	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 100,000	
		Total Construction Cost	**$ 975,000**	
	15%	Owner's Reserve for Change Orders	$ 100,000	
	15%	Engineering Services (Design)	$ 100,000	
	13%	Construction Management	$ 100,000	
	12%	Engineering Services During Construction	$ 100,000	
		TOTAL CAPITAL COST	**$ 1,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							$ -	
	Traffic Control (Heavy Urban)	7%	16	1,350	LS	$ 22.40	$ -	7% of Divisions 2-17
2 - Sitework							$ 500,000	
	16" Open Cut Pipeline		16	1,350	LF	$ 320	$ 400,000	
	16" HDD		16	250	LF	$ 448	$ 100,000	
	Sheeting and Shoring	7%	16	1,350	LF	$ 22.40	$ -	
	Potholing (Heavy Urban)	2%	16	1,600	LF	$ 6.40	$	
15 - Mechanical							$ 150,000	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					$ 3,000	
	Mechanical	2%		$ 150,000	$ 3,000	2% of Division 15
Labor Costs					$ 3,000	
	Annual Inspection and Pipeline Maintenance	1,600	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 6,000**	

Table B-10. Cost Estimate Details: DP10/11, 30-inch Purified Water Pipeline from GWR Alignment to Santa Clara Jenny Strand Park/Valley Water Treated Water PL



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP10/11 PL - Santa Clara/Jenny Strand TWA

Diam 30 inch

Length 11,200 feet

Date: 11/24/2020

Project Number: 437-001-105

Prepared By: C Lam

Cost Summary by Division

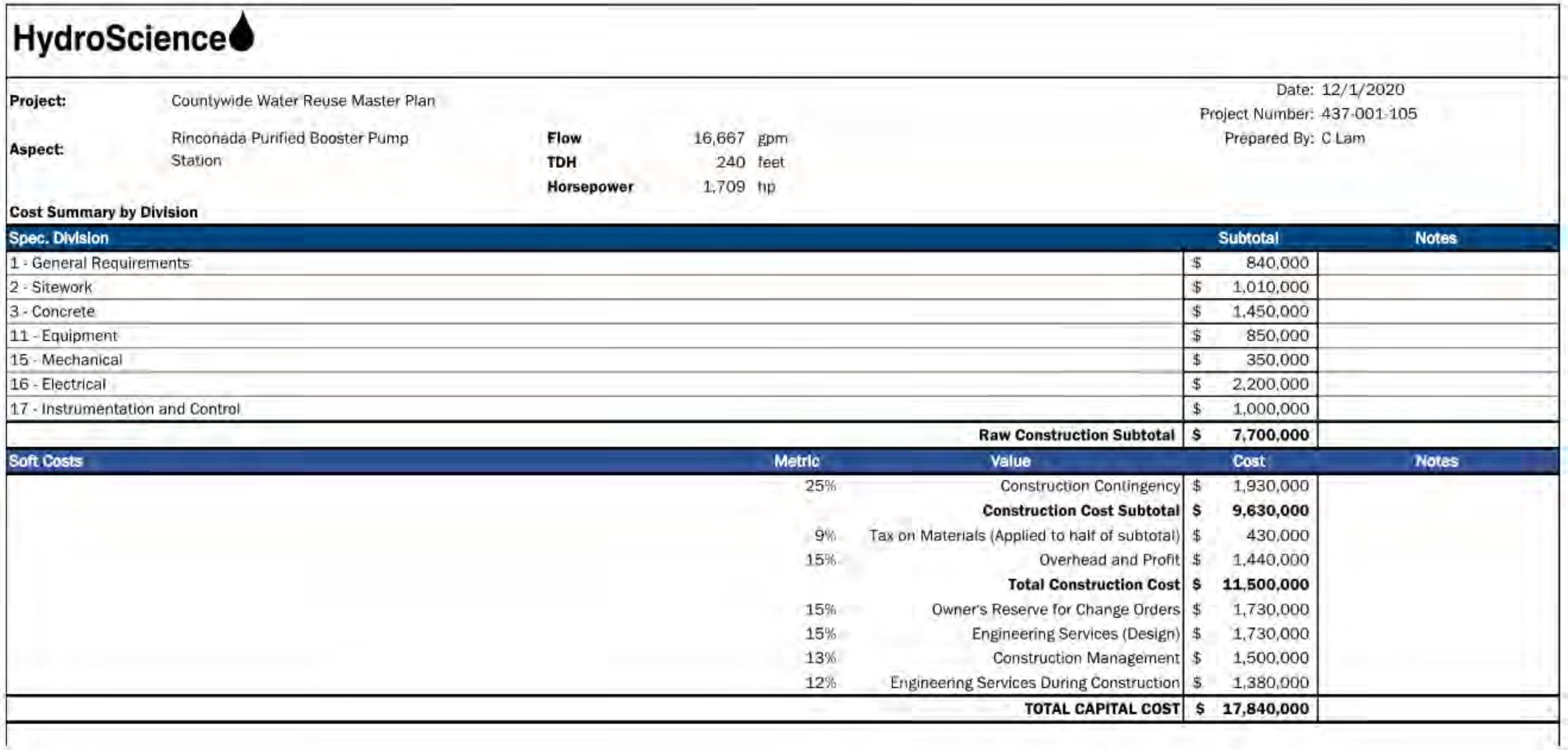
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 500,000	
2 - Sitework	$ 7,400,000	
15 - Mechanical	$ 150,000	
Raw Construction Subtotal	**$ 8,100,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,025,000	
		Construction Cost Subtotal	**$ 10,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,500,000	
		Total Construction Cost	**$ 12,125,000**	
	15%	Owner's Reserve for Change Orders	$ 1,800,000	
	15%	Engineering Services (Design)	$ 1,800,000	
	13%	Construction Management	$ 1,600,000	
	12%	Engineering Services During Construction	$ 1,500,000	
		TOTAL CAPITAL COST	**$ 18,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 500,000**	
	Traffic Control (Heavy Urban)	7%	30	11,000	LS	$ 42.00	$ 500,000	7% of Divisions 2-17
2 - Sitework							**$ 7,400,000**	
	12" Open Cut Pipeline		30	11,000	LF	$ 600	$ 6,600,000	
	12" HDD		30	200	LF	$ 840	$ 170,000	
	Sheeting and Shoring	7%	30	11,000	LF	$ 42.00	$ 500,000	
	Potholing (Heavy Urban)	2%	30	11,200	LF	$ 12.00	$ 130,000	
15 - Mechanical							**$ 150,000**	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 3,000**	
	Mechanical	2%		$ 150,000	$ 3,000	2% of Division 15
Labor Costs					**$ 18,000**	
	Annual Inspection and Pipeline Maintenance	11,200	LF	$1.63	$ 18,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 21,000**	

Table B-11. Cost Estimate Details: Purified Water Booster Pump Station from LGRP to Rinconada WTP (RWA Flex)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date: 12/1/2020 Project Number: 437-001-105 Prepared By: C Lam
Aspect:	Rinconada Purified Booster Pump Station	**Flow** **TDH** **Horsepower**	16,667 gpm 240 feet 1,709 hp	

Cost Summary by Division

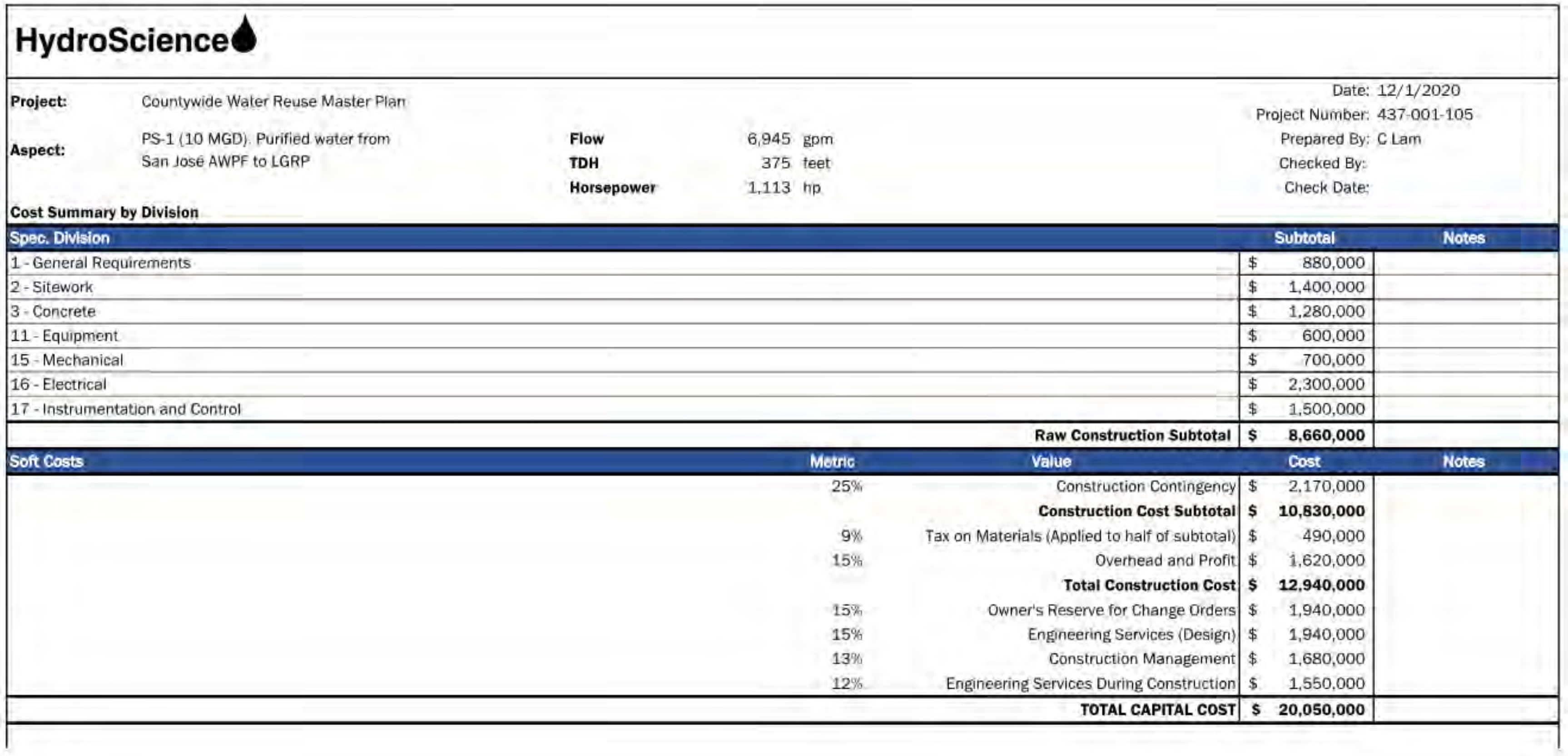
Spec. Division		Subtotal	Notes
1 - General Requirements	$	840,000	
2 - Sitework	$	1,010,000	
3 - Concrete	$	1,450,000	
11 - Equipment	$	850,000	
15 - Mechanical	$	350,000	
16 - Electrical	$	2,200,000	
17 - Instrumentation and Control	$	1,000,000	
Raw Construction Subtotal	**$**	**7,700,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,930,000	
		Construction Cost Subtotal	**$**	**9,630,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	430,000	
	15%	Overhead and Profit	$	1,440,000	
		Total Construction Cost	**$**	**11,500,000**	
	15%	Owner's Reserve for Change Orders	$	1,730,000	
	15%	Engineering Services (Design)	$	1,730,000	
	13%	Construction Management	$	1,500,000	
	12%	Engineering Services During Construction	$	1,380,000	
		TOTAL CAPITAL COST	**$**	**17,840,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 840,000**	
	Mobilization/Demobilization	10%	1	LS		$ 686,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						**$ 1,010,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 60,000	
	Asphalt Paving		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 200,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 125,000	
	Landscaping and irrigation		1	LS		$ 25,000	
3 - Concrete						**$ 1,450,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Equipment slabs	12 inch	1	LS		$ 200,000	
	Building slabs	18 inch	1	LS		$ 250,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 100,000	
	CMU Building	25 X 40 foot	1	LS		$ 800,000	+HVAC, finishes, aesthetics
11 - Equipment						**$ 850,000**	
	Centrifugal Pumps		1	LS		$ 750,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 350,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 100,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 250,000	
16 - Electrical						**$ 2,200,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,600,000	
	Standby generator		1	LS		$ 600,000	
17 - I&C						**$ 1,000,000**	
	I&C/SCADA/Programming Allowance					$ 1,000,000	

ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 88,000**	
	Equipment		2%		$850,000	$ 17,000	2% of Division 11
	Mechanical		2%		$350,000	$ 7,000	2% of Division 15
	Electrical		2%		$2,200,000	$ 44,000	2% of Division 16
	Instrumentation		2%		$1,000,000	$ 20,000	2% of Division 17
Power Costs						**$ 1,909,000**	
	Electricity Requirement	1,709 hp	10,048,451	kWh	$0.19	$ 1,909,000	50% utilization only assumed
					TOTAL ANNUAL O&M COSTS	**$ 1,997,000**	

Table B-12. Cost Estimate Details: PS-1, Purified Water Pump Station (up to 10 mgd) from San José AWPF to LGRP (Near-Term GWR Project)



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	12/1/2020
				Project Number:	437-001-105
Aspect:	PS-1 (10 MGD). Purified water from San José AWPF to LGRP	**Flow**	6,945 gpm	Prepared By:	C Lam
		TDH	375 feet	Checked By:	
		Horsepower	1,113 hp	Check Date:	

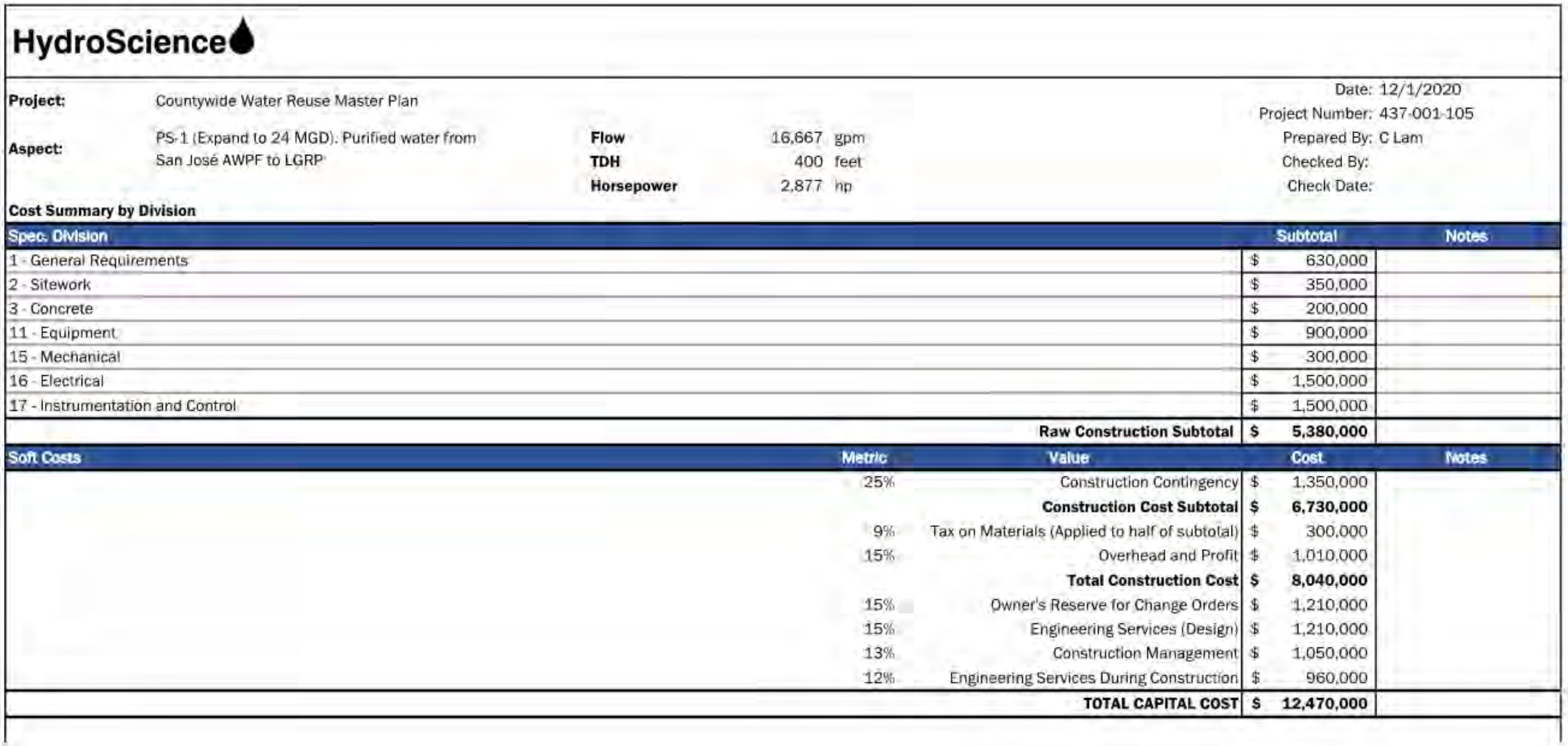
Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 880,000	
2 - Sitework	$ 1,400,000	
3 - Concrete	$ 1,280,000	
11 - Equipment	$ 600,000	
15 - Mechanical	$ 700,000	
16 - Electrical	$ 2,300,000	
17 - Instrumentation and Control	$ 1,500,000	
Raw Construction Subtotal	**$ 8,660,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,170,000	
		Construction Cost Subtotal	**$ 10,830,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 490,000	
	15%	Overhead and Profit	$ 1,620,000	
		Total Construction Cost	**$ 12,940,000**	
	15%	Owner's Reserve for Change Orders	$ 1,940,000	
	15%	Engineering Services (Design)	$ 1,940,000	
	13%	Construction Management	$ 1,680,000	
	12%	Engineering Services During Construction	$ 1,550,000	
		TOTAL CAPITAL COST	**$ 20,050,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 880,000**	
	Mobilization/Demobilization	10%	1	LS		$ 778,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 100,000	
2 - Sitework						**$ 1,400,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 300,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 150,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 300,000	
	Landscaping and irrigation		1	LS		$ 100,000	
3 - Concrete						**$ 1,280,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 100,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 600,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 400,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 700,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 500,000	
16 - Electrical						**$ 2,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 102,000**	
	Equipment		2%		$600,000	$ 12,000	2% of Division 11
	Mechanical		2%		$700,000	$ 14,000	2% of Division 15
	Electrical		2%		$2,300,000	$ 46,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 1,047,000**	
	Electricity Requirement	1,113 hp	6,542,353	kWh	$0.16	$ 1,047,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,149,000**	

Table B-13. Cost Estimate Details: PS-1, Purified Water Pump Station (Flexible Expansion, up to 24 mgd) from San José AWPF to LGRP (GWR Flex)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-1 (Expand to 24 MGD). Purified water from San José AWPF to LGRP

Flow 16,667 gpm
TDH 400 feet
Horsepower 2,877 hp

Date: 12/1/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By:
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	630,000	
2 - Sitework	$	350,000	
3 - Concrete	$	200,000	
11 - Equipment	$	900,000	
15 - Mechanical	$	300,000	
16 - Electrical	$	1,500,000	
17 - Instrumentation and Control	$	1,500,000	
Raw Construction Subtotal	**$**	**5,380,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,350,000	
		Construction Cost Subtotal	**$**	**6,730,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	300,000	
	15%	Overhead and Profit	$	1,010,000	
		Total Construction Cost	**$**	**8,040,000**	
	15%	Owner's Reserve for Change Orders	$	1,210,000	
	15%	Engineering Services (Design)	$	1,210,000	
	13%	Construction Management	$	1,050,000	
	12%	Engineering Services During Construction	$	960,000	
		TOTAL CAPITAL COST	**$**	**12,470,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 630,000**	
	Mobilization/Demobilization	10%	1	LS		$ 475,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						**$ 350,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 100,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 75,000	
	Dewatering		1	LS		$ 25,000	
	Shoring		1	LS		$ 50,000	
	Stormwater Management/SWPPP		1	LS		$ 75,000	
	Landscaping and irrigation		1	LS		$ 25,000	
3 - Concrete						**$ 200,000**	
	Equipment slabs	12 inch	1	LS		$ 100,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 100,000	
11 - Equipment						**$ 900,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 300,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 250,000	
16 - Electrical						**$ 1,500,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						**$ 84,000**	
	Equipment		2%		$900,000	$ 18,000	2% of Division 11
	Mechanical		2%		$300,000	$ 6,000	2% of Division 15
	Electrical		2%		$1,500,000	$ 30,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 1,659,000**	
	Electricity Requirement (Delta from 10 mgd)	1,764 hp	10,369,304	kWh	$0.16	$ 1,659,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,743,000**	

Table B-14. Life-cycle Unit Costs for San José 10 mgd Near-Term GWR Project

San Jose Near Term 10 mgd

Summary of Lifecycle Unit Costs ($/AF)

Time Horizon	Unit Costs, excluding ROC management: Low Estimate (Upper Bound Yield)	Unit Costs, excluding ROC management: High Estimate (Lower Bound Yield)	Unit Costs, excluding R&R and ROC management: Low Estimate (Upper Bound Yield)	Unit Costs, excluding R&R and ROC management: High Estimate (Lower Bound Yield)	ROCM Unit Costs Only: Lowest Cost Option Estimate	ROCM Unit Costs Only: Highest Cost Option Estimate	Unit Costs, including ROC management: Low Estimate	Unit Costs, including ROC management: High Estimate
100-Yr Lifecycle:	$ 2,400	$ 2,400	$ 2,000	$ 2,000	$ 200	200	$ 2,600	$ 2,600
30-Yr Lifecycle:	$ 3,100	$ 3,100	$ 2,900	$ 2,900	$ 200	200	$ 3,300	$ 3,300

[1] ROC management costs included for context only. The estimated ROC management lifecycle costs are based on Portfolio 1 as calculated in Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco. The flexible implementation scenarios assume that the ROC management strategy will be implemented in the near term with sufficient capacity to manage ROC from a 24 mgd plant. Although ROC management capital costs for the near term would be the same as in Portfolio 1, the O&M costs would be lower due to lower volumes of ROC, lowering the actual lifecycle cost for ROC management.

Lifecycle Cost Calculations, excluding ROC management

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars): Capital Cost	O&M Cost	R&R	Total Cost	Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
	100-Yr Lifecycle:	**$455,000,000**	**$870,000,000**	**$675,000,000**	**$2,000,000,000**	**$790,000,000**	**1,100,000**	**340,000**	**1,100,000**	**340,000**
	30-Yr Lifecycle:	**$455,000,000**	**$265,000,000**	**$115,000,000**	**$830,000,000**	**$595,000,000**	**330,000**	**192,000**	**330,000**	**192,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$113,750,000		$0	$113,750,000	$100,896,298				
2025		$113,750,000		$0	$113,750,000	$98,505,390				
2026		$113,750,000		$0	$113,750,000	$96,171,139				
2027		$113,750,000		$0	$113,750,000	$93,892,202				
2028	Year 1		$8,700,000	$0	$8,700,000	$7,011,035	11,000	8,865	11,000	8,865
2029	Year 2		$8,700,000	$0	$8,700,000	$6,844,897	11,000	8,654	11,000	8,654
2030	Year 3		$8,700,000	$0	$8,700,000	$6,682,695	11,000	8,449	11,000	8,449
2031	Year 4		$8,700,000	$0	$8,700,000	$6,524,338	11,000	8,249	11,000	8,249
2032	Year 5		$8,700,000	$0	$8,700,000	$6,369,733	11,000	8,054	11,000	8,054
2033	Year 6		$8,700,000	$0	$8,700,000	$6,218,791	11,000	7,863	11,000	7,863
2034	Year 7		$8,700,000	$0	$8,700,000	$6,071,426	11,000	7,677	11,000	7,677
2035	Year 8		$8,700,000	$204,002	$8,904,002	$6,066,546	11,000	7,495	11,000	7,495
2036	Year 9		$8,700,000	$0	$8,700,000	$5,787,090	11,000	7,317	11,000	7,317
2037	Year 10		$8,700,000	$1,953,104	$10,653,104	$6,918,341	11,000	7,144	11,000	7,144
2038	Year 11		$8,700,000	$0	$8,700,000	$5,516,070	11,000	6,974	11,000	6,974
2039	Year 12		$8,700,000	$0	$8,700,000	$5,385,358	11,000	6,809	11,000	6,809
2040	Year 13		$8,700,000	$0	$8,700,000	$5,257,743	11,000	6,648	11,000	6,648
2041	Year 14		$8,700,000	$0	$8,700,000	$5,133,152	11,000	6,490	11,000	6,490
2042	Year 15		$8,700,000	$1,893,401	$10,593,401	$6,102,180	11,000	6,336	11,000	6,336

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2043	Year 16		$8,700,000	$204,002	$8,904,002	$5,007,484	11,000	6,186	11,000	6,186
2044	Year 17		$8,700,000	$0	$8,700,000	$4,776,815	11,000	6,040	11,000	6,040
2045	Year 18		$8,700,000	$0	$8,700,000	$4,663,620	11,000	5,897	11,000	5,897
2046	Year 19		$8,700,000	$0	$8,700,000	$4,553,108	11,000	5,757	11,000	5,757
2047	Year 20		$8,700,000	$17,346,510	$26,046,510	$13,308,311	11,000	5,620	11,000	5,620
2048	Year 21		$8,700,000	$0	$8,700,000	$4,339,877	11,000	5,487	11,000	5,487
2049	Year 22		$8,700,000	$0	$8,700,000	$4,237,036	11,000	5,357	11,000	5,357
2050	Year 23		$8,700,000	$0	$8,700,000	$4,136,633	11,000	5,230	11,000	5,230
2051	Year 24		$8,700,000	$204,002	$8,904,002	$4,133,308	11,000	5,106	11,000	5,106
2052	Year 25		$8,700,000	$83,229,483	$91,929,483	$41,663,146	11,000	4,985	11,000	4,985
2053	Year 26		$8,700,000	$0	$8,700,000	$3,849,473	11,000	4,867	11,000	4,867
2054	Year 27		$8,700,000	$0	$8,700,000	$3,758,253	11,000	4,752	11,000	4,752
2055	Year 28		$8,700,000	$0	$8,700,000	$3,669,195	11,000	4,639	11,000	4,639
2056	Year 29		$8,700,000	$0	$8,700,000	$3,582,247	11,000	4,529	11,000	4,529
2057	Year 30		$8,700,000	$7,495,939	$16,195,939	$6,510,693	11,000	4,422	11,000	4,422
2058	Year 31		$8,700,000	$0	$8,700,000	$3,414,484	11,000	4,317	11,000	4,317
2059	Year 32		$8,700,000	$12,989	$8,712,989	$3,338,549	11,000	4,215	11,000	4,215
2060	Year 33		$8,700,000	$191,013	$8,891,013	$3,326,033	11,000	4,115	11,000	4,115
2061	Year 34		$8,700,000	$0	$8,700,000	$3,177,455	11,000	4,017	11,000	4,017
2062	Year 35		$8,700,000	$0	$8,700,000	$3,102,160	11,000	3,922	11,000	3,922
2063	Year 36		$8,700,000	$0	$8,700,000	$3,028,649	11,000	3,829	11,000	3,829
2064	Year 37		$8,700,000	$0	$8,700,000	$2,956,880	11,000	3,739	11,000	3,739
2065	Year 38		$8,700,000	$0	$8,700,000	$2,886,812	11,000	3,650	11,000	3,650
2066	Year 39		$8,700,000	$0	$8,700,000	$2,818,404	11,000	3,563	11,000	3,563
2067	Year 40		$8,700,000	$19,015,508	$27,715,508	$8,765,800	11,000	3,479	11,000	3,479
2068	Year 41		$8,700,000	$191,013	$8,891,013	$2,745,394	11,000	3,397	11,000	3,397
2069	Year 42		$8,700,000	$0	$8,700,000	$2,622,754	11,000	3,316	11,000	3,316
2070	Year 43		$8,700,000	$0	$8,700,000	$2,560,603	11,000	3,238	11,000	3,238
2071	Year 44		$8,700,000	$0	$8,700,000	$2,499,925	11,000	3,161	11,000	3,161
2072	Year 45		$8,700,000	$1,893,401	$10,593,401	$2,971,857	11,000	3,086	11,000	3,086
2073	Year 46		$8,700,000	$0	$8,700,000	$2,382,849	11,000	3,013	11,000	3,013
2074	Year 47		$8,700,000	$0	$8,700,000	$2,326,384	11,000	2,941	11,000	2,941
2075	Year 48		$8,700,000	$12,989	$8,712,989	$2,274,647	11,000	2,872	11,000	2,872
2076	Year 49		$8,700,000	$191,013	$8,891,013	$2,266,120	11,000	2,804	11,000	2,804
2077	Year 50		$8,700,000	$101,508,875	$110,208,875	$27,424,135	11,000	2,737	11,000	2,737
2078	Year 51		$8,700,000	$0	$8,700,000	$2,113,588	11,000	2,672	11,000	2,672
2079	Year 52		$8,700,000	$0	$8,700,000	$2,063,503	11,000	2,609	11,000	2,609
2080	Year 53		$8,700,000	$0	$8,700,000	$2,014,605	11,000	2,547	11,000	2,547
2081	Year 54		$8,700,000	$0	$8,700,000	$1,966,866	11,000	2,487	11,000	2,487
2082	Year 55		$8,700,000	$0	$8,700,000	$1,920,257	11,000	2,428	11,000	2,428
2083	Year 56		$8,700,000	$12,989	$8,712,989	$1,877,553	11,000	2,370	11,000	2,370
2084	Year 57		$8,700,000	$0	$8,700,000	$1,830,328	11,000	2,314	11,000	2,314
2085	Year 58		$8,700,000	$191,013	$8,891,013	$1,826,189	11,000	2,259	11,000	2,259
2086	Year 59		$8,700,000	$0	$8,700,000	$1,744,611	11,000	2,206	11,000	2,206

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$8,700,000	$22,635,461	$31,335,461	$6,134,796	11,000	2,154	11,000	2,154
2088	Year 61		$8,700,000	$4,553	$8,704,553	$1,663,777	11,000	2,103	11,000	2,103
2089	Year 62		$8,700,000	$6,690	$8,706,690	$1,624,750	11,000	2,053	11,000	2,053
2090	Year 63		$8,700,000	$9,734	$8,709,734	$1,586,804	11,000	2,004	11,000	2,004
2091	Year 64		$8,700,000	$27,010	$8,727,010	$1,552,275	11,000	1,957	11,000	1,957
2092	Year 65		$8,700,000	$19,997	$8,719,997	$1,514,273	11,000	1,910	11,000	1,910
2093	Year 66		$8,700,000	$219,250	$8,919,250	$1,512,171	11,000	1,865	11,000	1,865
2094	Year 67		$8,700,000	$39,473	$8,739,473	$1,446,581	11,000	1,821	11,000	1,821
2095	Year 68		$8,700,000	$54,633	$8,754,633	$1,414,751	11,000	1,778	11,000	1,778
2096	Year 69		$8,700,000	$74,861	$8,774,861	$1,384,418	11,000	1,735	11,000	1,735
2097	Year 70		$8,700,000	$3,215,488	$11,915,488	$1,835,369	11,000	1,694	11,000	1,694
2098	Year 71		$8,700,000	$136,405	$8,836,405	$1,328,838	11,000	1,654	11,000	1,654
2099	Year 72		$8,700,000	$194,375	$8,894,375	$1,305,860	11,000	1,615	11,000	1,615
2100	Year 73		$8,700,000	$238,801	$8,938,801	$1,281,284	11,000	1,577	11,000	1,577
2101	Year 74		$8,700,000	$502,273	$9,202,273	$1,287,792	11,000	1,539	11,000	1,539
2102	Year 75		$8,700,000	$137,711,802	$146,411,802	$20,003,758	11,000	1,503	11,000	1,503
2103	Year 76		$8,700,000	$513,181	$9,213,181	$1,228,938	11,000	1,467	11,000	1,467
2104	Year 77		$8,700,000	$649,127	$9,349,127	$1,217,520	11,000	1,433	11,000	1,433
2105	Year 78		$8,700,000	$812,919	$9,512,919	$1,209,494	11,000	1,399	11,000	1,399
2106	Year 79		$8,700,000	$1,007,906	$9,707,906	$1,205,036	11,000	1,365	11,000	1,365
2107	Year 80		$8,700,000	$19,995,787	$28,695,787	$3,477,583	11,000	1,333	11,000	1,333
2108	Year 81		$8,700,000	$1,503,618	$10,203,618	$1,207,253	11,000	1,301	11,000	1,301
2109	Year 82		$8,700,000	$1,809,182	$10,509,182	$1,213,942	11,000	1,271	11,000	1,271
2110	Year 83		$8,700,000	$2,346,193	$11,046,193	$1,245,737	11,000	1,241	11,000	1,241
2111	Year 84		$8,700,000	$2,541,805	$11,241,805	$1,237,754	11,000	1,211	11,000	1,211
2112	Year 85		$8,700,000	$2,967,959	$11,667,959	$1,254,232	11,000	1,182	11,000	1,182
2113	Year 86		$8,700,000	$3,431,079	$12,131,079	$1,273,114	11,000	1,154	11,000	1,154
2114	Year 87		$8,700,000	$3,926,994	$12,626,994	$1,293,757	11,000	1,127	11,000	1,127
2115	Year 88		$8,700,000	$4,462,857	$13,162,857	$1,316,702	11,000	1,100	11,000	1,100
2116	Year 89		$8,700,000	$4,992,190	$13,692,190	$1,337,196	11,000	1,074	11,000	1,074
2117	Year 90		$8,700,000	$12,413,439	$21,113,439	$2,013,103	11,000	1,049	11,000	1,049
2118	Year 91		$8,700,000	$6,288,487	$14,988,487	$1,395,242	11,000	1,024	11,000	1,024
2119	Year 92		$8,700,000	$6,638,423	$15,338,423	$1,393,982	11,000	1,000	11,000	1,000
2120	Year 93		$8,700,000	$7,155,451	$15,855,451	$1,406,824	11,000	976	11,000	976
2121	Year 94		$8,700,000	$7,636,004	$16,336,004	$1,415,115	11,000	953	11,000	953
2122	Year 95		$8,700,000	$8,067,748	$16,767,748	$1,418,096	11,000	930	11,000	930
2123	Year 96		$8,700,000	$8,452,078	$17,152,078	$1,416,225	11,000	908	11,000	908
2124	Year 97		$8,700,000	$8,739,687	$17,439,687	$1,405,850	11,000	887	11,000	887
2125	Year 98		$8,700,000	$8,960,934	$17,660,934	$1,389,949	11,000	866	11,000	866
2126	Year 99		$8,700,000	$9,287,374	$17,987,374	$1,382,094	11,000	845	11,000	845
2127	Year 100		$8,700,000	$135,460,739	$144,160,739	$10,814,380	11,000	825	11,000	825

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Attachment C: San José Pipeline Sizing Cost Analysis

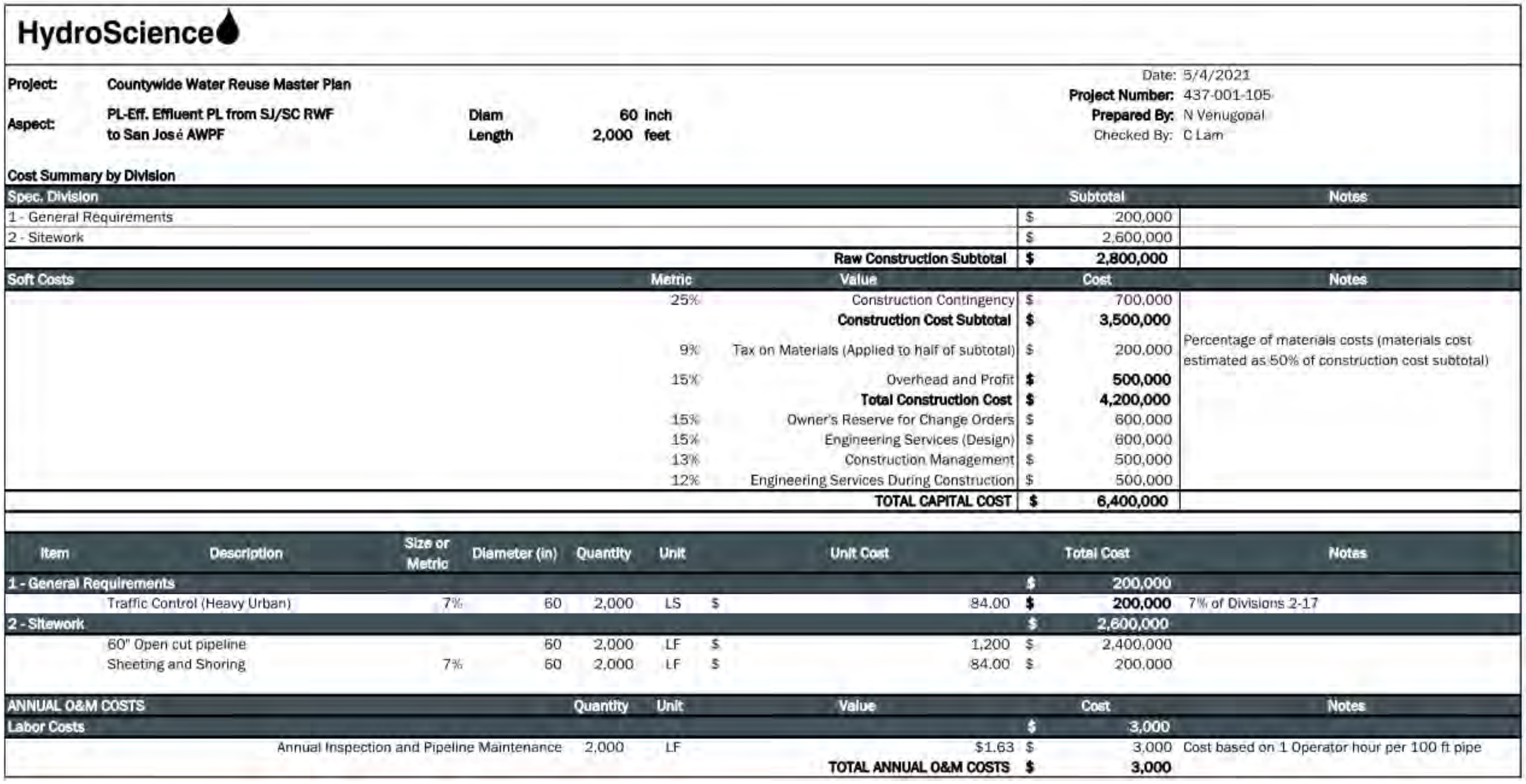
Table C-1. Overview of Costs for Various San José Pipeline Diameter Options

Reference: CoRe Plan, App. A-6	Reference: CoRe Plan, App A-10, Att. C	ID no.	Project element	Location or start point	End point	**Diameter (in)**	Horse-power (hp)	Length (LF)	Length (miles)	**Conveyance Costs**			
										Capital	Annual O&M	Rounded Capital	Rounded Annual O&M
Modified Portfolio 1a: Conveyance for 24 mgd between SJ AWPF and LGRP, with future capacity (up to 40 mgd)													
--	Table C-2	PL-Eff	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	2,000	0.4	$ 6	$ 0.003	$ 320	$ 3.4
--	Table C-4	PL-O	Purified Water Pipeline	San José AWPF	LGRP	**48**	--	95,490	18.1	$ 264	$ 0.2		
--	Table C-12	PS-OPF	Pump Station (24 mgd)	San José AWPF	LGRP	--	2,849	--	--	$ 28	$ 2.8		
Table 6	--	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	$ 15	$ 0.4		
--	--	PL Easements	Easement[a]	--	--	--	--	97,490	18.5	$ 3	$ -		
TOTAL												**$ 320**	**$ 3.4**
Modified Portfolio 1a: Conveyance for up to 24 mgd between SJ AWPF and LGRP													
--	Table C-2	PL-Eff	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	2,000	0.4	$ 6	$ 0.003	$ 245	$ 3.4
--	Table C-5	PL-S	Purified Water Pipeline	San José AWPF	LGRP	**36**	--	95,490	18.1	$ 188	$ 0.2		
--	Table C-12	PS-OPF	Pump Station (24 mgd)	San José AWPF	LGRP	--	2,849	--	--	$ 28	$ 2.8		
Table 6	--	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	$ 15	$ 0.4		
--	--	PL Easements	Easement[a]	--	--	--	--	97,490	18.5	$ 3	$ -		
TOTAL												**$ 245**	**$ 3.4**
Modified Portfolio 1a: Conveyance for up to 24 mgd between SJ AWPF and LGRP, with 14 mgd for TWA and 10 mgd for GWR													
--	Table C-2	PL-Eff	Effluent Pipeline	SJ/SC RWF	San José AWPF	60	--	2,000	0.4	$ 6	$ 0.003	$ 210	$ 3.4
--	Table C-6	PL-OP1	Purified Water Pipeline	San José AWPF	Levi Stadium	**36**	--	23,224	4.4	$ 46	$ 0.04		
--	Table C-7	PL-OP2	Purified Water Pipeline	Levi Stadium	Pruneridge Ave	**30**	--	37,829	7.2	$ 63	$ 0.1		
--	Table C-8	PL-OP3	Purified Water Pipeline	Pruneridge Ave	LGRP	**24**	--	35,128	6.7	$ 46	$ 0.1		
--	Table C-12	PS-OPF	Pump Station (24 mgd)	San José AWPF	LGRP	--	2,849	--	--	$ 28	$ 2.8		
Table 6	--	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	$ 15	$ 0.4		
--	--	PL Easements	Easement[a]	--	--	--	--	98,181	18.6	$ 3	$ -		
TOTAL												**$ 210**	**$ 3.4**
Modified Portfolio 1a: Conveyance for up to 16 mgd between SJ AWPF and LGRP													
--	Table C-3	PL-Eff-48 in	Effluent Pipeline - 48-inch	SJ/SC RWF	San José AWPF	48	--	2,000	0.4	$ 5	$ 0.003	$ 210	$ 2.4
--	Table C-9	PL-S-30 in	Purified Water Pipeline	San José AWPF	LGRP	**30**	--	95,490	18.1	$ 155	$ 0.2		
--	Table C-13	PS-S-16 mgd	Pump Station (16 mgd)	San José AWPF	LGRP	--	1,769	--	--	$ 28	$ 1.8		
Table 6	--	LGRP-1	LGRP Site Improvements	--	--	--		--	--	$ 15	$ 0.4		
--	--	PL Easements	Easement[a]	--	--	--		97,490	18.5	$ 3	$ -		
TOTAL												**$ 210**	**$ 2.4**
Modified Portfolio 1a: Conveyance for up to 10 mgd between SJ AWPF and LGRP													
--	Table C-3	PL-Eff-48	Effluent Pipeline - 48-inch	SJ/SC RWF	San José AWPF	48	--	2,000	0.4	$ 5	$ 0.003	$ 165	$ 1.7
--	Table C-10	PL-OP1-24	Purified Water Pipeline	San José AWPF	Levi Stadium	**24**	--	23,224	4.4	$ 30	$ 0.04		
--	Table C-11	PL-OP2-24	Purified Water Pipeline	Levi Stadium	Pruneridge Ave	**24**	--	37,829	7.2	$ 49	$ 0.1		
--	Table C-8	PL-OP3	Purified Water Pipeline	Pruneridge Ave	LGRP	**24**	--	35,128	6.7	$ 46	$ 0.1		
--	Table C-14	PS-OPI	Pump Station (10 mgd)	San José AWPF	LGRP	--	1,113	--	--	$ 17	$ 1.1		
Table 6	--	LGRP-1	LGRP Site Improvements	--	--	--	--	--	--	$ 15	$ 0.4		
--	--	PL Easements	Easement[a]	--	--	--	--	25,224	4.8	$ 1	$ -		
TOTAL												**$ 165**	**$ 1.7**

a. Assumes that pipeline easement cost is $32/foot.

b. All costs reported in July 2019 dollars.

Table C-2. Cost Estimate Details: PL-Eff, 60-inch Effluent Pipeline from SJ/SC RWF to San José AWPF



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-Eff. Effluent PL from SJ/SC RWF to San José AWPF**

Diam **60 inch**
Length **2,000 feet**

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

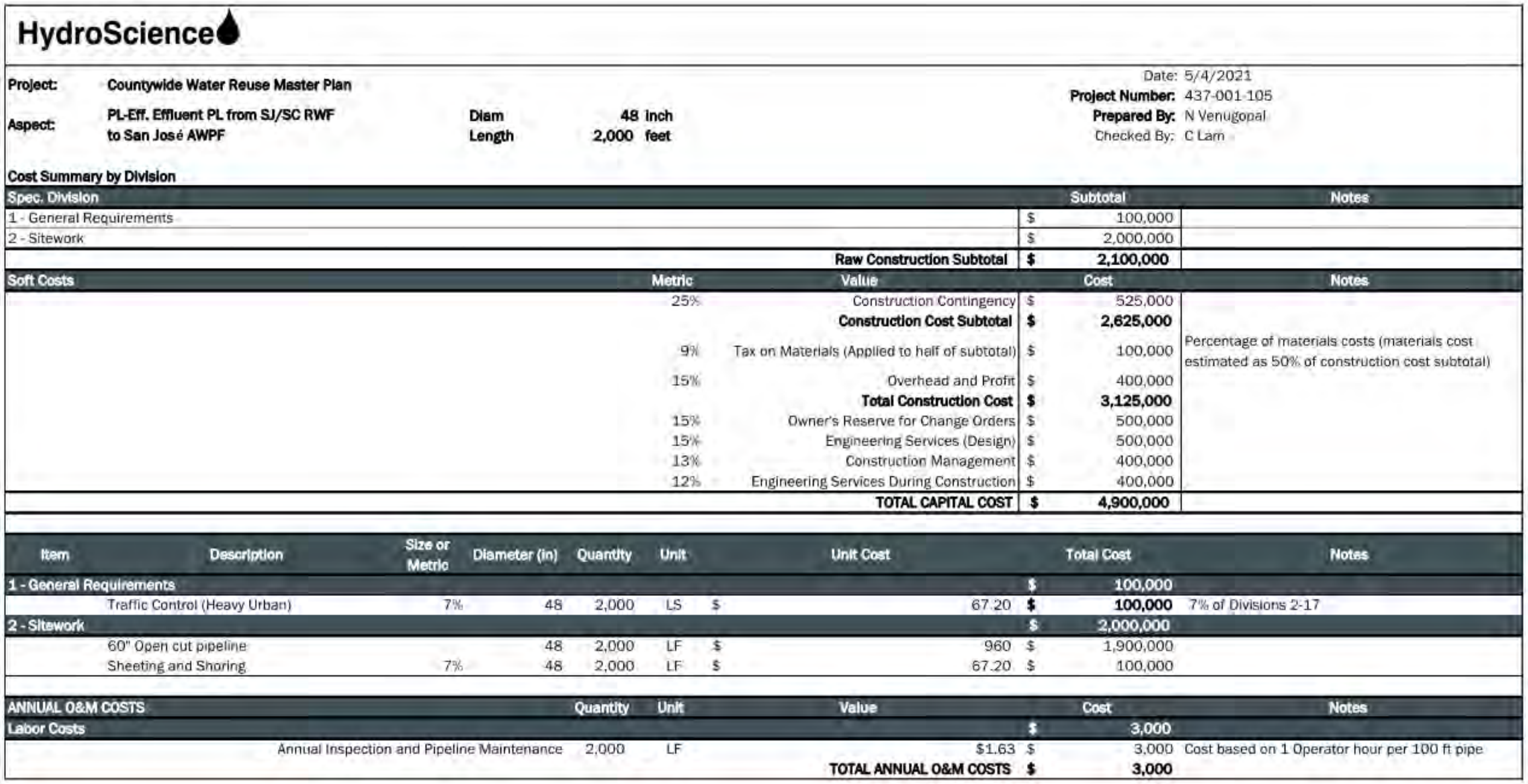
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 200,000	
2 - Sitework	$ 2,600,000	
Raw Construction Subtotal	**$ 2,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 700,000	
		Construction Cost Subtotal	**$ 3,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	**$ 500,000**	
		Total Construction Cost	**$ 4,200,000**	
	15%	Owner's Reserve for Change Orders	$ 600,000	
	15%	Engineering Services (Design)	$ 600,000	
	13%	Construction Management	$ 500,000	
	12%	Engineering Services During Construction	$ 500,000	
		TOTAL CAPITAL COST	**$ 6,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 200,000**	
	Traffic Control (Heavy Urban)	7%	60	2,000	LS	$ 84.00	**$ 200,000**	7% of Divisions 2-17
2 - Sitework							**$ 2,600,000**	
	60" Open cut pipeline		60	2,000	LF	$ 1,200	$ 2,400,000	
	Sheeting and Shoring	7%	60	2,000	LF	$ 84.00	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 3,000**	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 3,000**	

Table C-3. Cost Estimate Details: PL-Eff, 48-inch Effluent Pipeline from SJ/SC RWF to San José AWPF



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/4/2021
				Project Number:	437-001-105
Aspect:	**PL-Eff. Effluent PL from SJ/SC RWF to San José AWPF**	**Diam**	**48 inch**	**Prepared By:**	N Venugopal
		Length	**2,000 feet**	Checked By:	C Lam

Cost Summary by Division

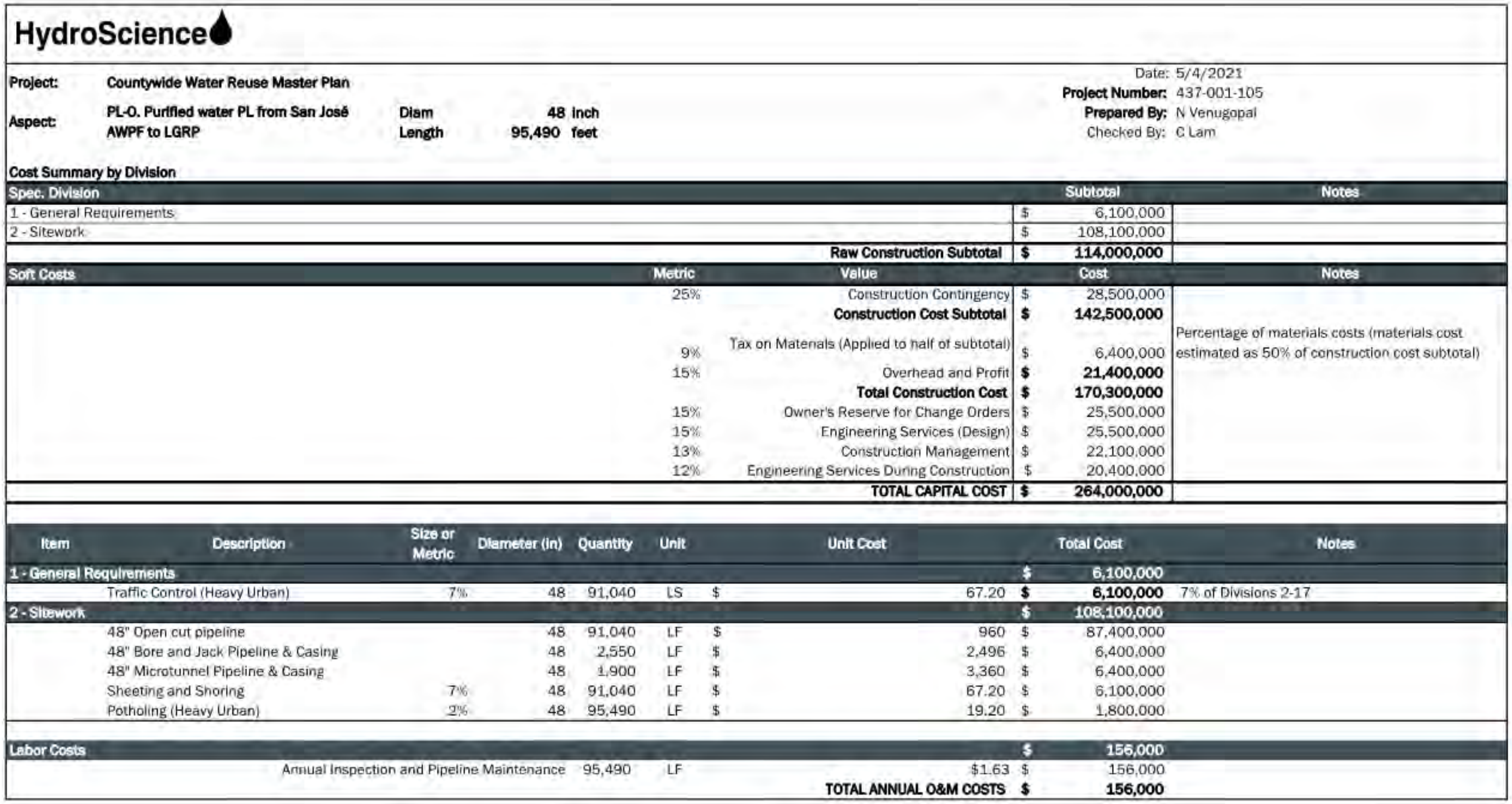
Spec. Division		Subtotal	Notes
1 - General Requirements	$	100,000	
2 - Sitework	$	2,000,000	
Raw Construction Subtotal	**$**	**2,100,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	525,000	
		Construction Cost Subtotal	**$**	**2,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	400,000	
		Total Construction Cost	**$**	**3,125,000**	
	15%	Owner's Reserve for Change Orders	$	500,000	
	15%	Engineering Services (Design)	$	500,000	
	13%	Construction Management	$	400,000	
	12%	Engineering Services During Construction	$	400,000	
		TOTAL CAPITAL COST	**$**	**4,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**100,000**	
	Traffic Control (Heavy Urban)	7%	48	2,000	LS	$ 67.20	**$**	**100,000**	7% of Divisions 2-17
2 - Sitework							**$**	**2,000,000**	
	60" Open cut pipeline		48	2,000	LF	$ 960	$	1,900,000	
	Sheeting and Shoring	7%	48	2,000	LF	$ 67.20	$	100,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**3,000**	
Annual Inspection and Pipeline Maintenance	2,000	LF	$1.63	$	3,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**3,000**	

Table C-4. Cost Estimate Details: PL-0, 48-inch Purified Water Pipeline from San José AWPF to LGRP



HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **PL-O. Purified water PL from San José AWPF to LGRP**
Diam **48 inch**
Length **95,490 feet**

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

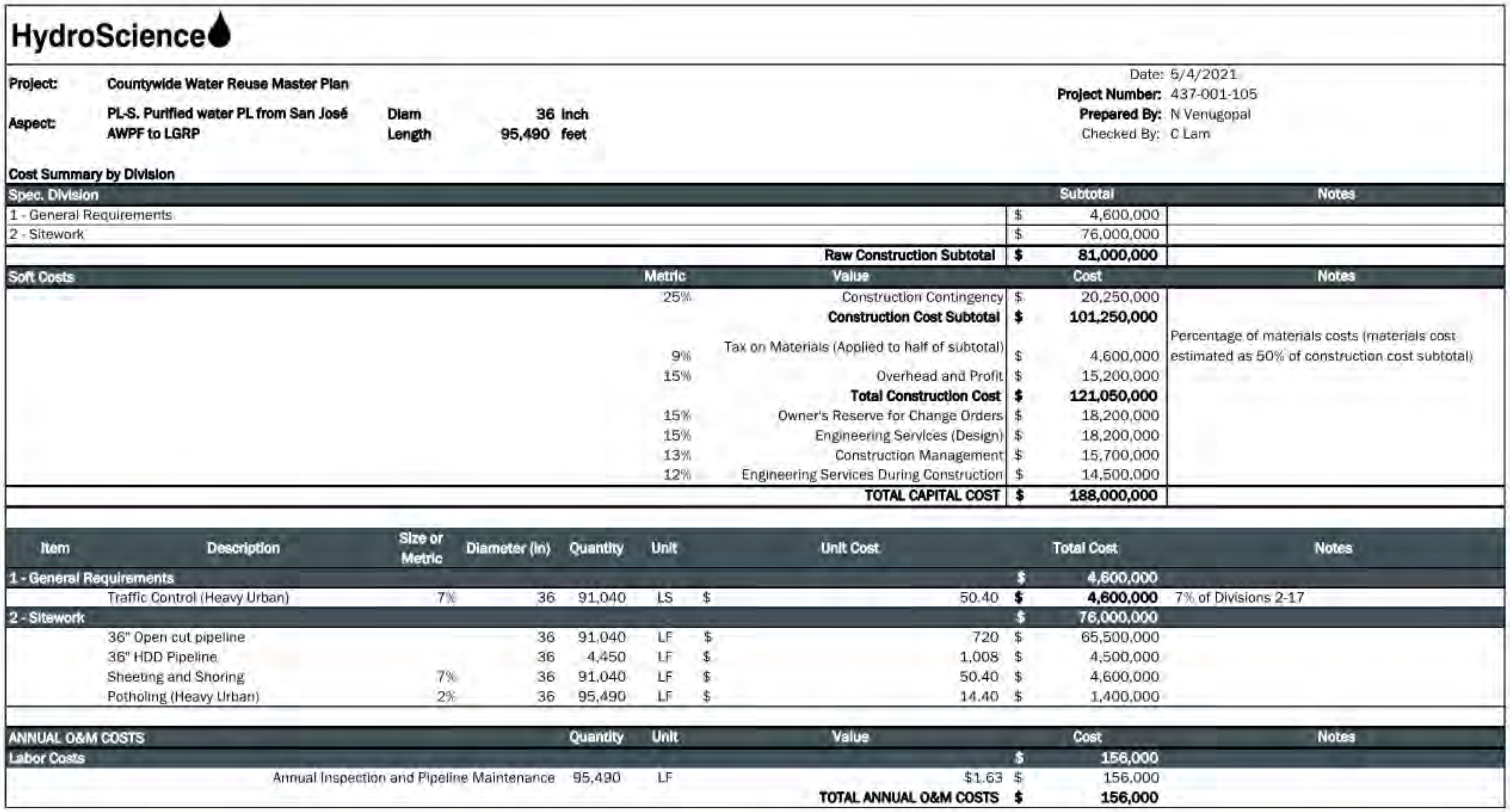
Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 6,100,000	
2 - Sitework		$ 108,100,000	
	Raw Construction Subtotal	**$ 114,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 28,500,000	
		Construction Cost Subtotal	**$ 142,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	**$ 21,400,000**	
		Total Construction Cost	**$ 170,300,000**	
	15%	Owner's Reserve for Change Orders	$ 25,500,000	
	15%	Engineering Services (Design)	$ 25,500,000	
	13%	Construction Management	$ 22,100,000	
	12%	Engineering Services During Construction	$ 20,400,000	
		TOTAL CAPITAL COST	**$ 264,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 6,100,000**	
	Traffic Control (Heavy Urban)	7%	48	91,040	LS	$ 67.20	**$ 6,100,000**	7% of Divisions 2-17
2 - Sitework							**$ 108,100,000**	
	48" Open cut pipeline		48	91,040	LF	$ 960	$ 87,400,000	
	48" Bore and Jack Pipeline & Casing		48	2,550	LF	$ 2,496	$ 6,400,000	
	48" Microtunnel Pipeline & Casing		48	1,900	LF	$ 3,360	$ 6,400,000	
	Sheeting and Shoring	7%	48	91,040	LF	$ 67.20	$ 6,100,000	
	Potholing (Heavy Urban)	2%	48	95,490	LF	$ 19.20	$ 1,800,000	
Labor Costs							**$ 156,000**	
	Annual Inspection and Pipeline Maintenance			95,490	LF	$1.63	$ 156,000	
						TOTAL ANNUAL O&M COSTS	**$ 156,000**	

Table C-5. Cost Estimate Details: PL-S, 36-inch Purified Water Pipeline from San José AWPF to LGRP



HydroScience

Project: **Countywide Water Reuse Master Plan**
Aspect: **PL-S. Purified water PL from San José AWPF to LGRP** **Diam** **36** **inch** **Length** **95,490** **feet**

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

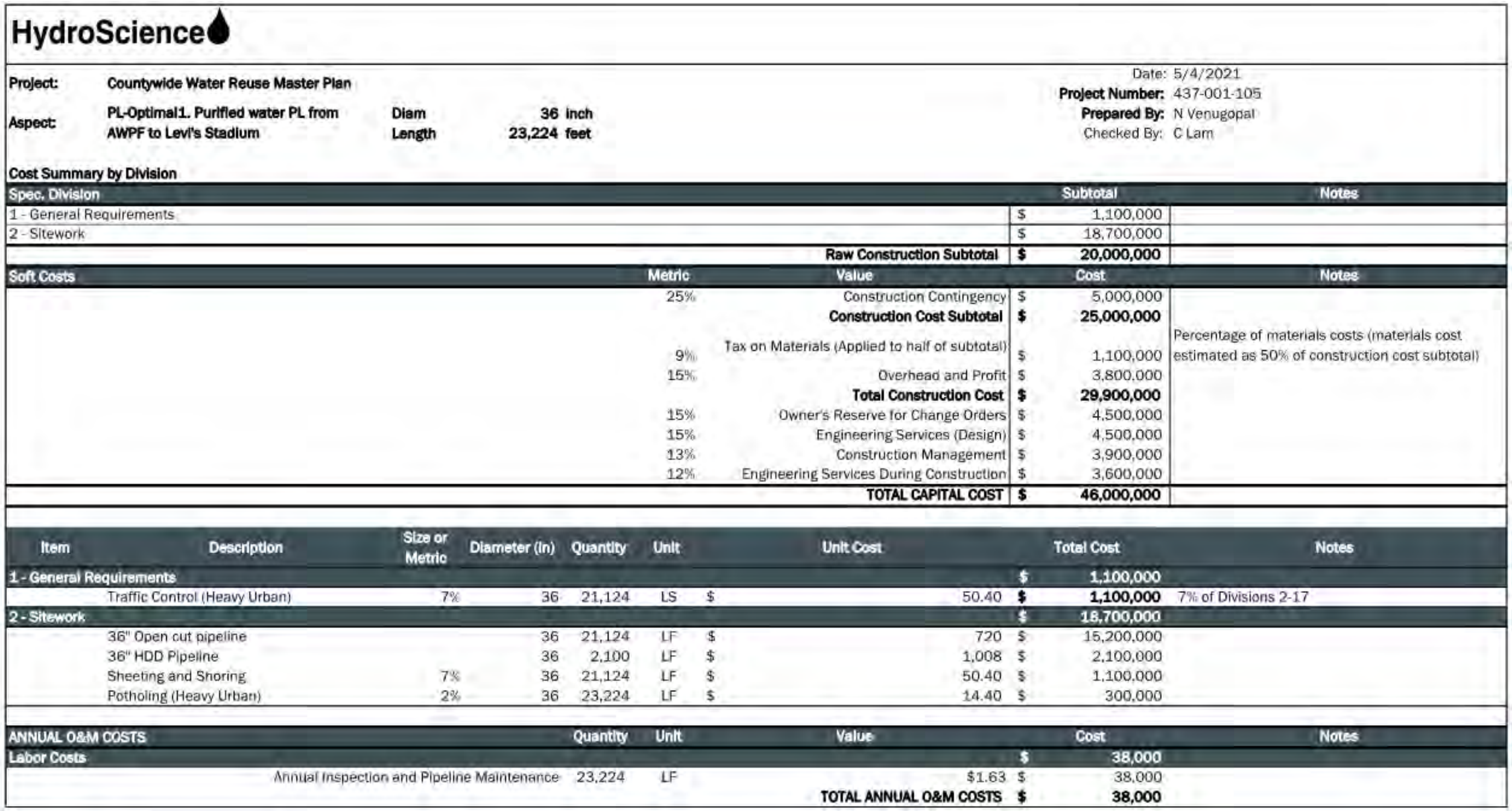
Spec. Division		Subtotal	Notes
1 - General Requirements	$	4,600,000	
2 - Sitework	$	76,000,000	
Raw Construction Subtotal	**$**	**81,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	20,250,000	
		Construction Cost Subtotal	**$**	**101,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	4,600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	15,200,000	
		Total Construction Cost	**$**	**121,050,000**	
	15%	Owner's Reserve for Change Orders	$	18,200,000	
	15%	Engineering Services (Design)	$	18,200,000	
	13%	Construction Management	$	15,700,000	
	12%	Engineering Services During Construction	$	14,500,000	
		TOTAL CAPITAL COST	**$**	**188,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**4,600,000**	
	Traffic Control (Heavy Urban)	7%	36	91,040	LS	$ 50.40	**$**	**4,600,000**	7% of Divisions 2-17
2 - Sitework							**$**	**76,000,000**	
	36" Open cut pipeline		36	91,040	LF	$ 720	$	65,500,000	
	36" HDD Pipeline		36	4,450	LF	$ 1,008	$	4,500,000	
	Sheeting and Shoring	7%	36	91,040	LF	$ 50.40	$	4,600,000	
	Potholing (Heavy Urban)	2%	36	95,490	LF	$ 14.40	$	1,400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**156,000**	
Annual Inspection and Pipeline Maintenance	95,490	LF	$1.63	$	156,000	
			TOTAL ANNUAL O&M COSTS	**$**	**156,000**	

Table C-6. Cost Estimate Details: PL-Optimal 1, 36-inch Purified Water Pipeline from AWPF to Levi's Stadium



HydroScience

Project:	**Countywide Water Reuse Master Plan**			Date:	5/4/2021
				Project Number:	437-001-105
Aspect:	**PL-Optimal1. Purified water PL from AWPF to Levi's Stadium**	**Diam**	**36 inch**	**Prepared By:**	N Venugopal
		Length	**23,224 feet**	Checked By:	C Lam

Cost Summary by Division

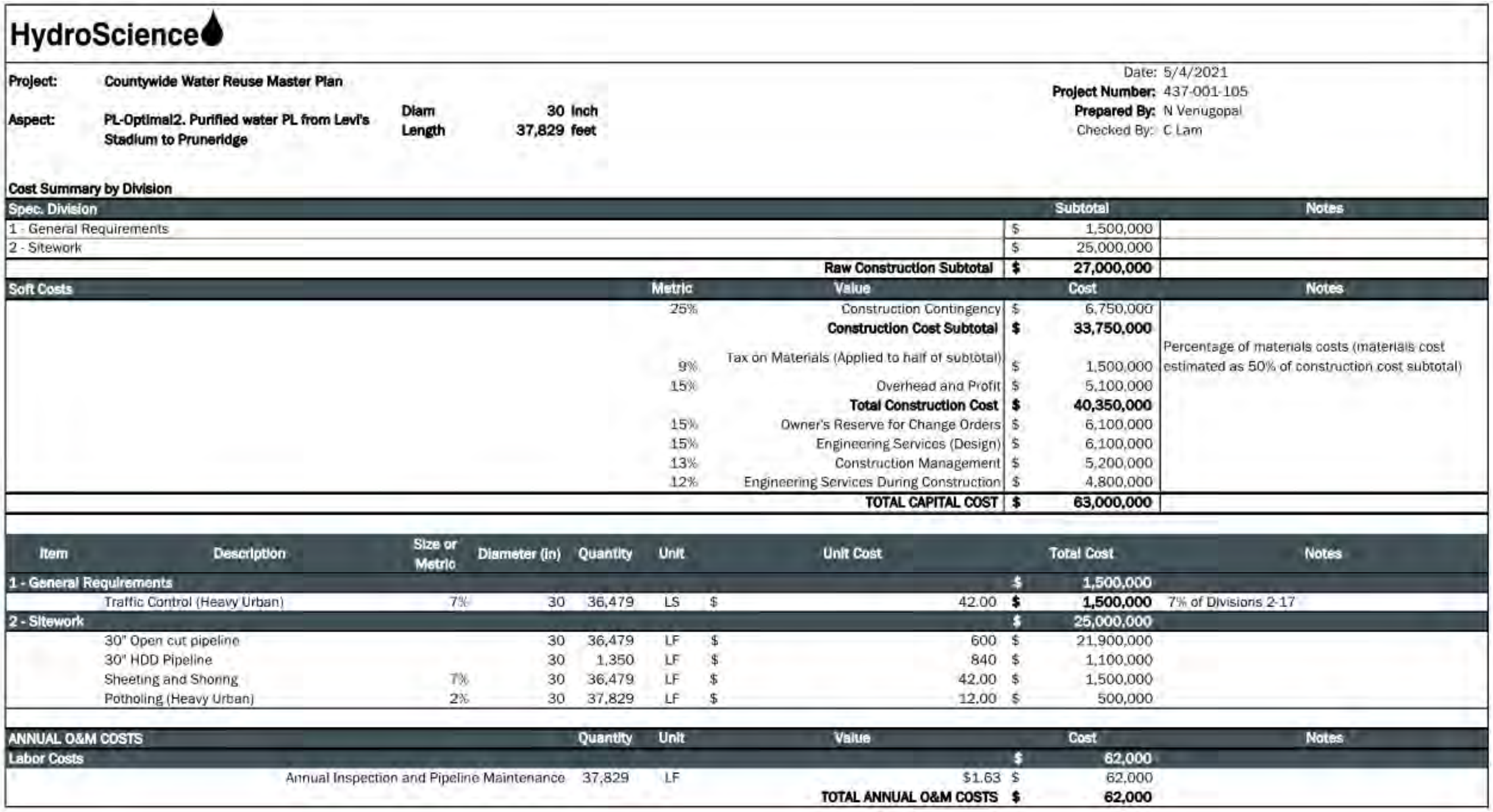
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,100,000	
2 - Sitework	$	18,700,000	
Raw Construction Subtotal	**$**	**20,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	5,000,000	
		Construction Cost Subtotal	**$**	**25,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	3,800,000	
		Total Construction Cost	**$**	**29,900,000**	
	15%	Owner's Reserve for Change Orders	$	4,500,000	
	15%	Engineering Services (Design)	$	4,500,000	
	13%	Construction Management	$	3,900,000	
	12%	Engineering Services During Construction	$	3,600,000	
		TOTAL CAPITAL COST	**$**	**46,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**1,100,000**	
	Traffic Control (Heavy Urban)	7%	36	21,124	LS	$ 50.40	**$**	**1,100,000**	7% of Divisions 2-17
2 - Sitework							**$**	**18,700,000**	
	36" Open cut pipeline		36	21,124	LF	$ 720	$	15,200,000	
	36" HDD Pipeline		36	2,100	LF	$ 1,008	$	2,100,000	
	Sheeting and Shoring	7%	36	21,124	LF	$ 50.40	$	1,100,000	
	Potholing (Heavy Urban)	2%	36	23,224	LF	$ 14.40	$	300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**38,000**	
Annual Inspection and Pipeline Maintenance	23,224	LF	$1.63	$	38,000	
			TOTAL ANNUAL O&M COSTS	**$**	**38,000**	

Table C-7. Cost Estimate Details: PL-Optimal 2, 30-inch Purified Water Pipeline from Levi's Stadium to Pruneridge



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-Optimal2. Purified water PL from Levi's Stadium to Pruneridge

Diam 30 inch

Length 37,829 feet

Date: 5/4/2021

Project Number: 437-001-105

Prepared By: N Venugopal

Checked By: C Lam

Cost Summary by Division

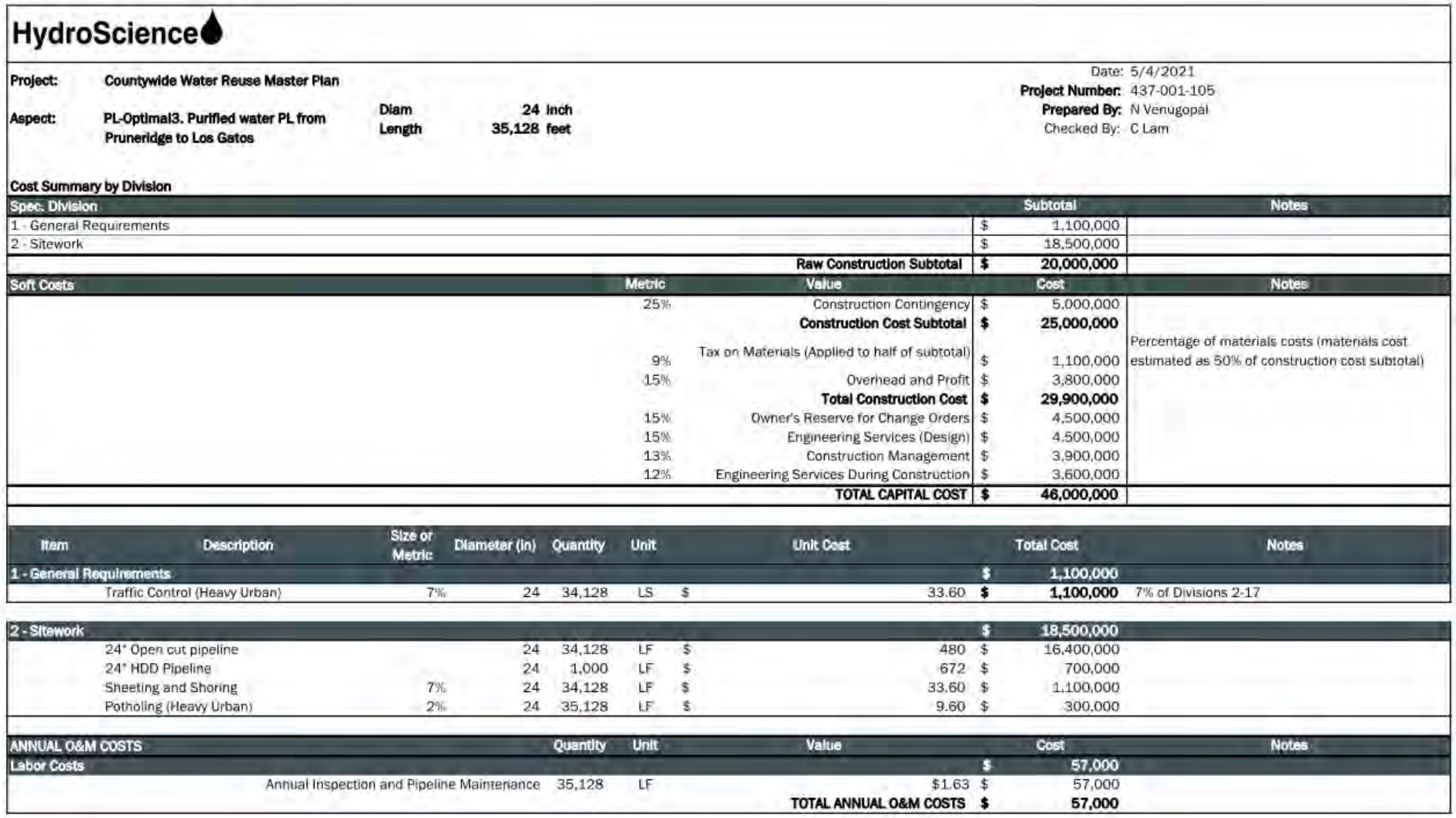
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,500,000	
2 - Sitework	$	25,000,000	
Raw Construction Subtotal	**$**	**27,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	6,750,000	
		Construction Cost Subtotal	**$**	**33,750,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	5,100,000	
		Total Construction Cost	**$**	**40,350,000**	
	15%	Owner's Reserve for Change Orders	$	6,100,000	
	15%	Engineering Services (Design)	$	6,100,000	
	13%	Construction Management	$	5,200,000	
	12%	Engineering Services During Construction	$	4,800,000	
		TOTAL CAPITAL COST	**$**	**63,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,500,000**	
	Traffic Control (Heavy Urban)	7%	30	36,479	LS	$	42.00	**$**	**1,500,000**	7% of Divisions 2-17
2 - Sitework								**$**	**25,000,000**	
	30" Open cut pipeline		30	36,479	LF	$	600	$	21,900,000	
	30" HDD Pipeline		30	1,350	LF	$	840	$	1,100,000	
	Sheeting and Shoring	7%	30	36,479	LF	$	42.00	$	1,500,000	
	Potholing (Heavy Urban)	2%	30	37,829	LF	$	12.00	$	500,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**62,000**	
Annual Inspection and Pipeline Maintenance	37,829	LF	$1.63	$	62,000	
			TOTAL ANNUAL O&M COSTS	**$**	**62,000**	

Table C-8. Cost Estimate Details: PL-Optimal 3, 24-inch Purified Water Pipeline from Pruneridge to Los Gatos



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PL-Optimal3. Purified water PL from Pruneridge to Los Gatos
Diam 24 inch
Length 35,128 feet

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

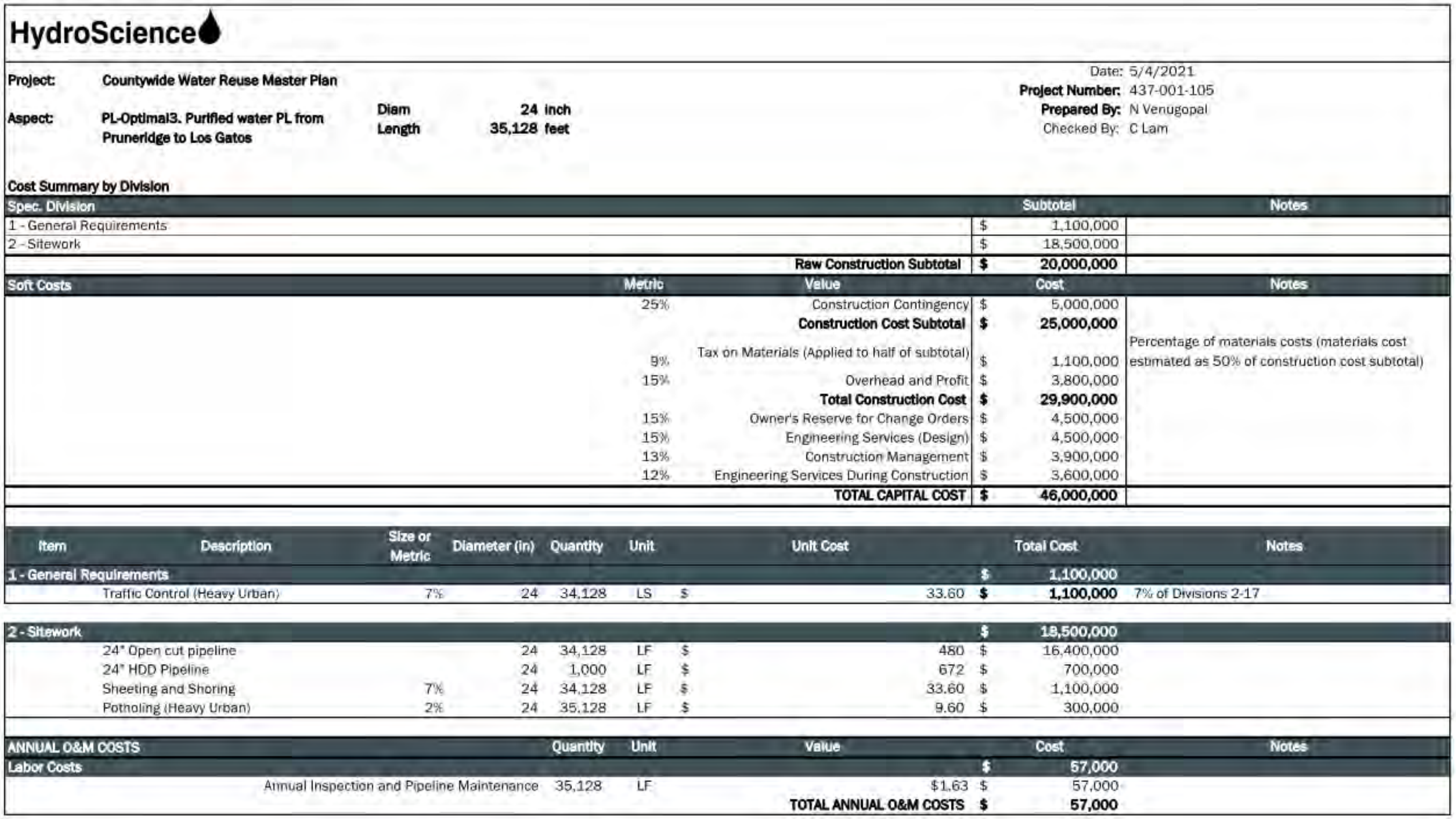
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,100,000	
2 - Sitework	$	18,500,000	
Raw Construction Subtotal	**$**	**20,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	5,000,000	
		Construction Cost Subtotal	**$**	**25,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	3,800,000	
		Total Construction Cost	**$**	**29,900,000**	
	15%	Owner's Reserve for Change Orders	$	4,500,000	
	15%	Engineering Services (Design)	$	4,500,000	
	13%	Construction Management	$	3,900,000	
	12%	Engineering Services During Construction	$	3,600,000	
		TOTAL CAPITAL COST	**$**	**46,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,100,000**	
	Traffic Control (Heavy Urban)	7%	24	34,128	LS	$	33.60	**$**	**1,100,000**	7% of Divisions 2-17
2 - Sitework								**$**	**18,500,000**	
	24" Open cut pipeline		24	34,128	LF	$	480	$	16,400,000	
	24" HDD Pipeline		24	1,000	LF	$	672	$	700,000	
	Sheeting and Shoring	7%	24	34,128	LF	$	33.60	$	1,100,000	
	Potholing (Heavy Urban)	2%	24	35,128	LF	$	9.60	$	300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**57,000**	
Annual Inspection and Pipeline Maintenance	35,128	LF	$1.63	$	57,000	
			TOTAL ANNUAL O&M COSTS	**$**	**57,000**	

Table C-8. Cost Estimate Details: PL-Optimal 3, 24-inch Purified Water Pipeline from Pruneridge to Los Gatos



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PL-Optimal3. Purified water PL from Pruneridge to Los Gatos**

Diam **24 inch**
Length **35,128 feet**

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

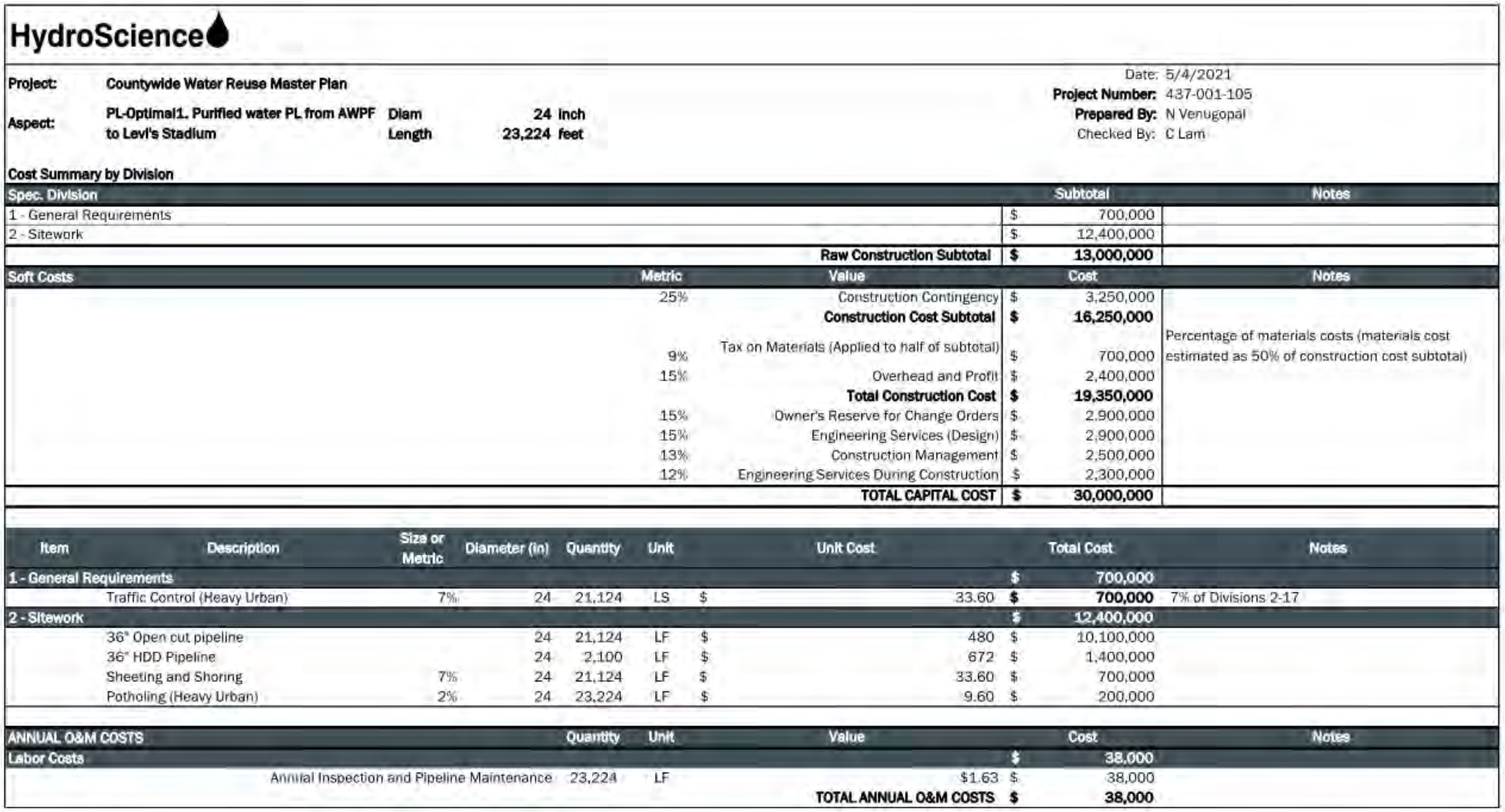
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,100,000	
2 - Sitework	$	18,500,000	
Raw Construction Subtotal	**$**	**20,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	5,000,000	
		Construction Cost Subtotal	**$**	**25,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	3,800,000	
		Total Construction Cost	**$**	**29,900,000**	
	15%	Owner's Reserve for Change Orders	$	4,500,000	
	15%	Engineering Services (Design)	$	4,500,000	
	13%	Construction Management	$	3,900,000	
	12%	Engineering Services During Construction	$	3,600,000	
		TOTAL CAPITAL COST	**$**	**46,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,100,000**	
	Traffic Control (Heavy Urban)	7%	24	34,128	LS	$	33.60	**$**	**1,100,000**	7% of Divisions 2-17
2 - Sitework								**$**	**18,500,000**	
	24" Open cut pipeline		24	34,128	LF	$	480	$	16,400,000	
	24" HDD Pipeline		24	1,000	LF	$	672	$	700,000	
	Sheeting and Shoring	7%	24	34,128	LF	$	33.60	$	1,100,000	
	Potholing (Heavy Urban)	2%	24	35,128	LF	$	9.60	$	300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**57,000**	
Annual Inspection and Pipeline Maintenance	35,128	LF	$1.63	$	57,000	
			TOTAL ANNUAL O&M COSTS	**$**	**57,000**	

Table C-10. Cost Estimate Details: PL-Optimal 1, 24-inch Purified Water Pipeline from AWPF to Levi's Stadium



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-Optimal1. Purified water PL from AWPF to Levi's Stadium

Diam 24 inch

Length 23,224 feet

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

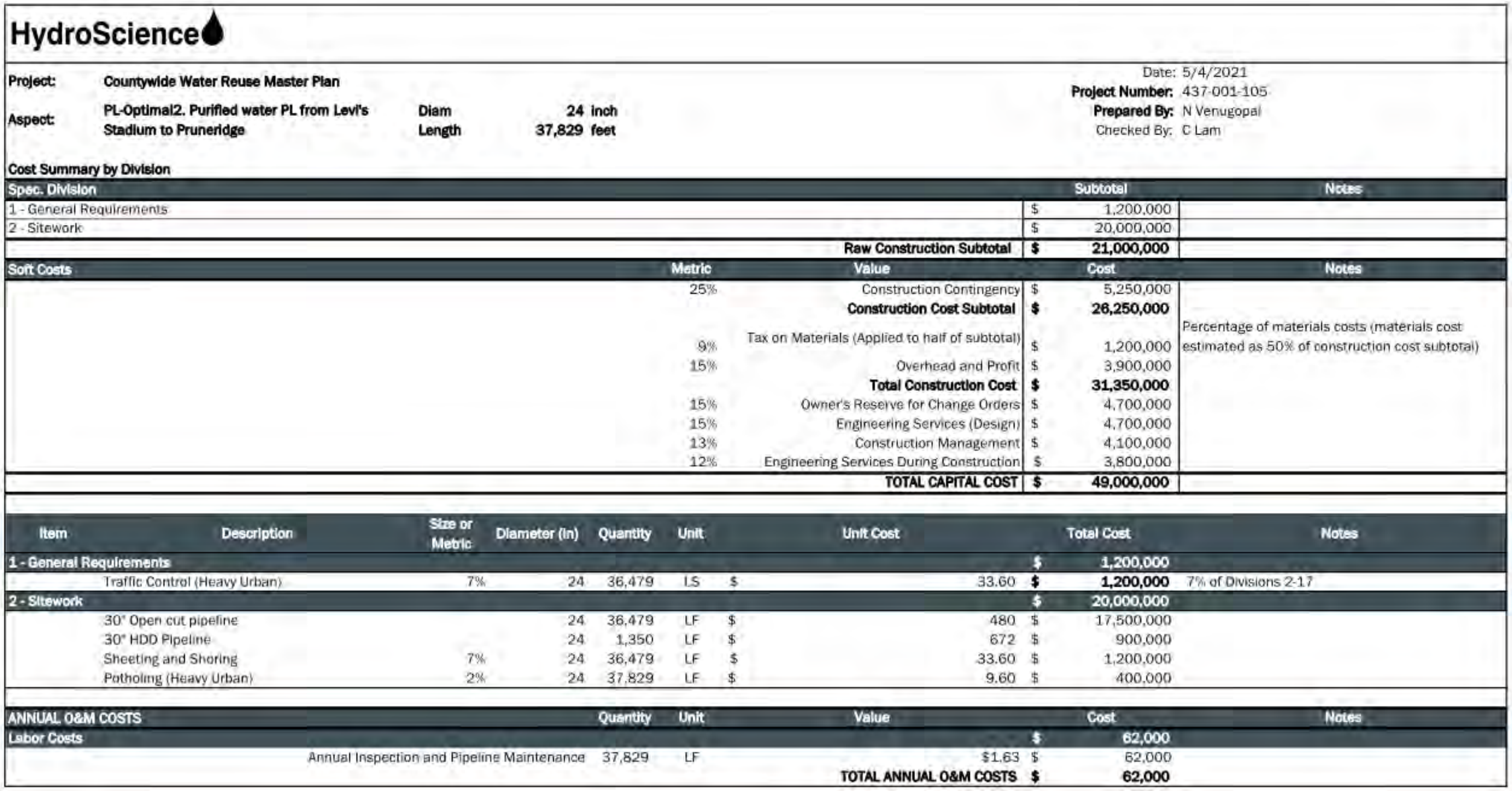
Spec. Division		Subtotal	Notes
1 - General Requirements	$	700,000	
2 - Sitework	$	12,400,000	
Raw Construction Subtotal	**$**	**13,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,250,000	
		Construction Cost Subtotal	**$**	**16,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,400,000	
		Total Construction Cost	**$**	**19,350,000**	
	15%	Owner's Reserve for Change Orders	$	2,900,000	
	15%	Engineering Services (Design)	$	2,900,000	
	13%	Construction Management	$	2,500,000	
	12%	Engineering Services During Construction	$	2,300,000	
		TOTAL CAPITAL COST	**$**	**30,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**700,000**	
	Traffic Control (Heavy Urban)	7%	24	21,124	LS	$	33.60	**$**	**700,000**	7% of Divisions 2-17
2 - Sitework								**$**	**12,400,000**	
	36" Open cut pipeline		24	21,124	LF	$	480	$	10,100,000	
	36" HDD Pipeline		24	2,100	LF	$	672	$	1,400,000	
	Sheeting and Shoring	7%	24	21,124	LF	$	33.60	$	700,000	
	Potholing (Heavy Urban)	2%	24	23,224	LF	$	9.60	$	200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**38,000**	
Annual Inspection and Pipeline Maintenance	23,224	LF	$1.63	$	38,000	
			TOTAL ANNUAL O&M COSTS	**$**	**38,000**	

Table C-11. Cost Estimate Details: PL-Optimal 2, 24-inch Purified Water Pipeline from Levi's Stadium to Pruneridge



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-Optimal2. Purified water PL from Levi's Stadium to Pruneridge

Diam 24 inch
Length 37,829 feet

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

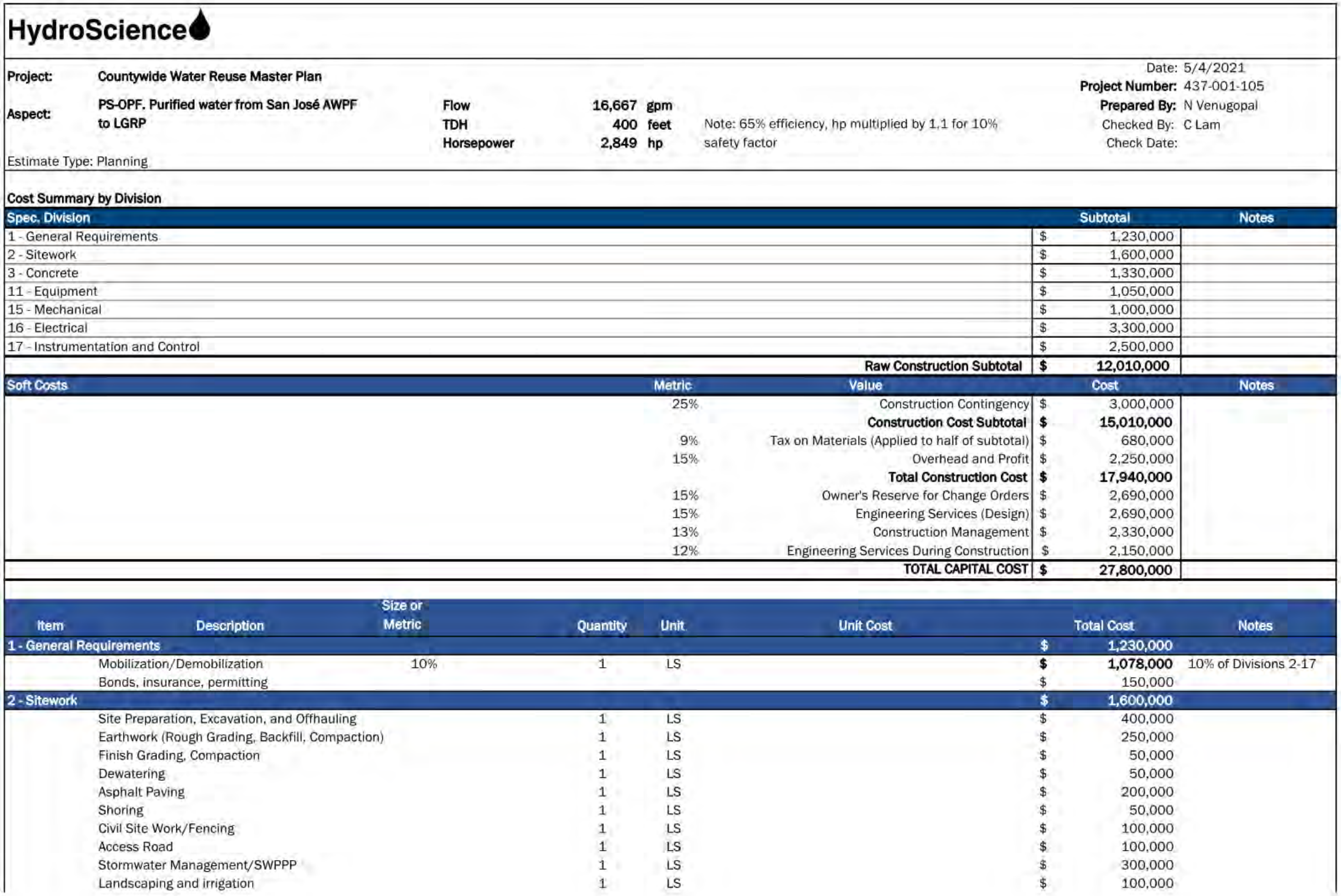
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,200,000	
2 - Sitework	$	20,000,000	
Raw Construction Subtotal	**$**	**21,000,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	5,250,000	
		Construction Cost Subtotal	**$**	**26,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	3,900,000	
		Total Construction Cost	**$**	**31,350,000**	
	15%	Owner's Reserve for Change Orders	$	4,700,000	
	15%	Engineering Services (Design)	$	4,700,000	
	13%	Construction Management	$	4,100,000	
	12%	Engineering Services During Construction	$	3,800,000	
		TOTAL CAPITAL COST	**$**	**49,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**1,200,000**	
	Traffic Control (Heavy Urban)	7%	24	36,479	LS	$	33.60	**$**	**1,200,000**	7% of Divisions 2-17
2 - Sitework								**$**	**20,000,000**	
	30" Open cut pipeline		24	36,479	LF	$	480	$	17,500,000	
	30" HDD Pipeline		24	1,350	LF	$	672	$	900,000	
	Sheeting and Shoring	7%	24	36,479	LF	$	33.60	$	1,200,000	
	Potholing (Heavy Urban)	2%	24	37,829	LF	$	9.60	$	400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**62,000**	
Annual Inspection and Pipeline Maintenance	37,829	LF	$1.63	$	62,000	
			TOTAL ANNUAL O&M COSTS	**$**	**62,000**	

Table C-12. Cost Estimate Details: PS-OPF, Purified Water Pump Station from San José AWPF to LGRP to convey up to 24 mgd



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PS-OPF. Purified water from San José AWPF to LGRP**

Flow	**16,667**	**gpm**
TDH	**400**	**feet**
Horsepower	**2,849**	**hp**

Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Estimate Type: Planning

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

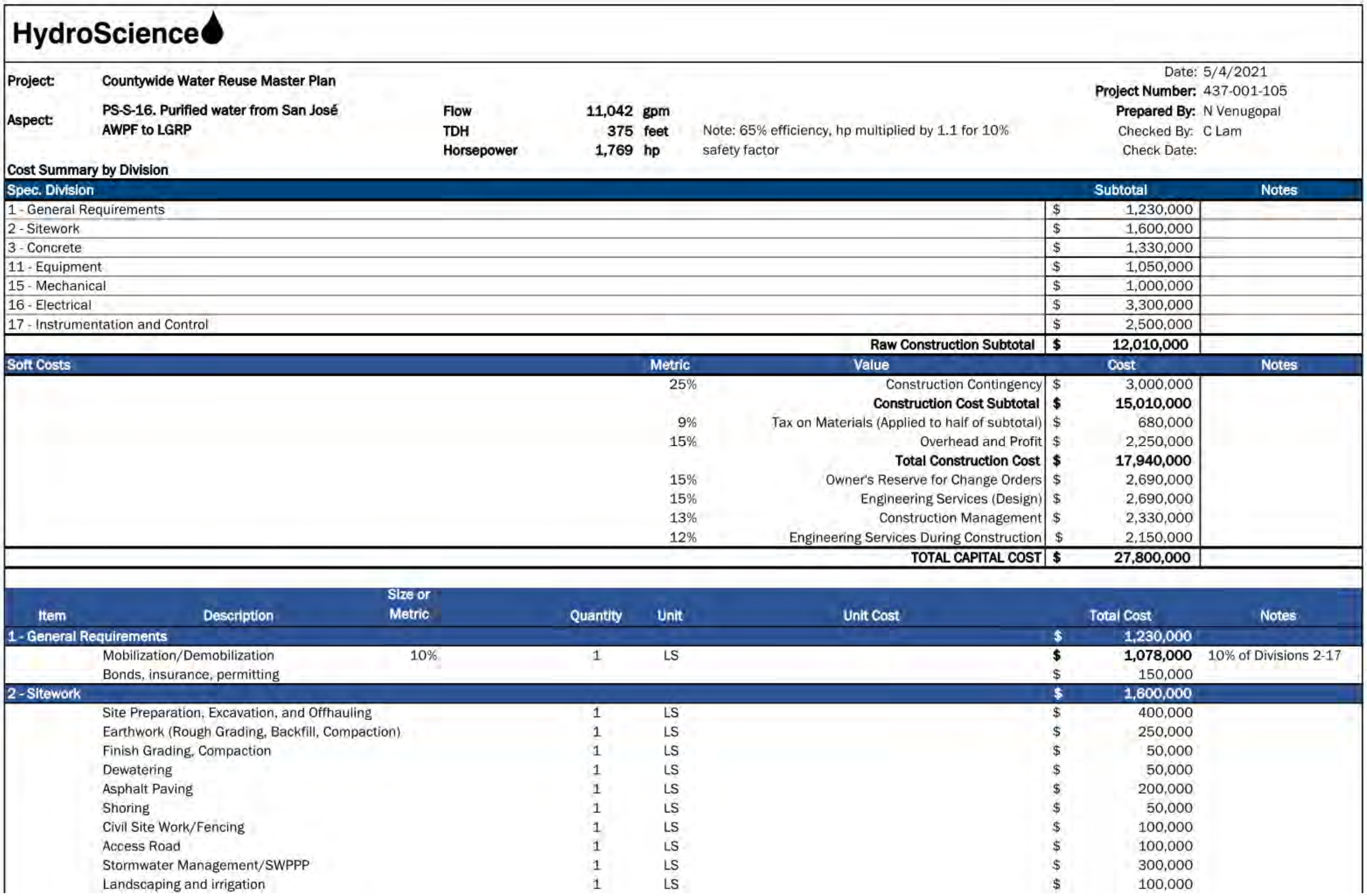
Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**1,230,000**	
	Mobilization/Demobilization	10%	1	LS		**$**	**1,078,000**	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,600,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 1,330,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 150,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 1,050,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						**$ 1,000,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						**$ 157,000**	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 2,680,000**	
	Electricity Requirement	2,849 hp	16,747,418	kWh	$0.16	$ 2,680,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,837,000**	

Table C-13. Cost Estimate Details: PS-S, Purified Water Pump Station from San José AWPF to LGRP to convey up to 16 mgd



HydroScience

Project: **Countywide Water Reuse Master Plan**

Aspect: **PS-S-16. Purified water from San José AWPF to LGRP**

Flow	**11,042**	**gpm**
TDH	**375**	**feet**
Horsepower	**1,769**	**hp**

Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor

Date: 5/4/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

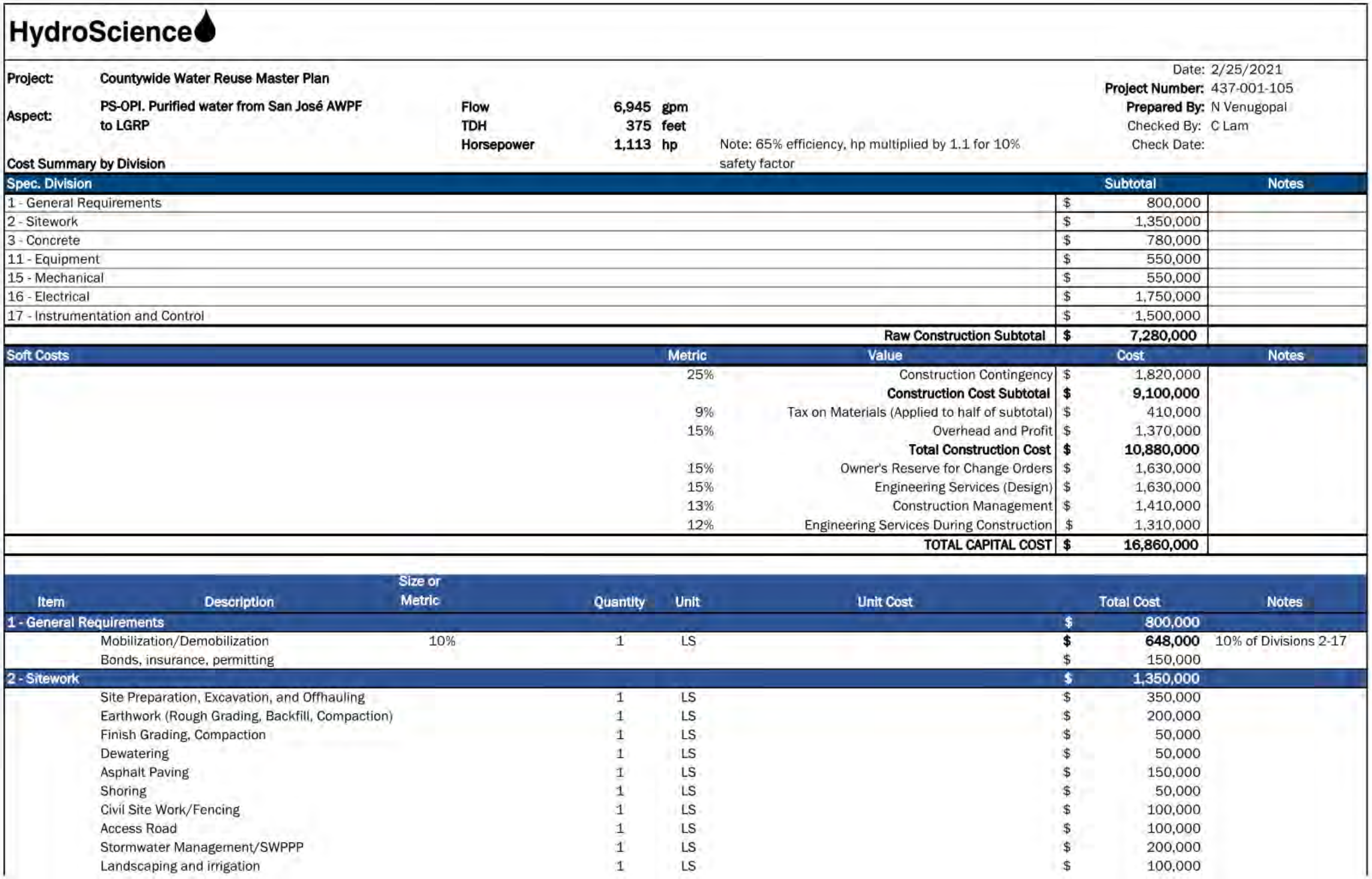
Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**1,230,000**	
	Mobilization/Demobilization	10%	1	LS		**$**	**1,078,000**	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,600,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	

Item	Description	Size or Metric		Quantity	Unit	Unit Cost		Total Cost	Notes
3 - Concrete							**$**	**1,330,000**	
	Structural Concrete	18	inch	1	LS		$	400,000	
	Vaults	12	inch	1	LS		$	200,000	
	Equipment slabs	12	inch	1	LS		$	150,000	
	Building slabs	18	inch	1	LS		$	75,000	
	Miscellaneous Concrete	18	inch	1	LS		$	200,000	
	CMU Building	25 X 40	foot	1	LS		$	300,000	
11 - Equipment							**$**	**1,050,000**	
	Vertical turbine pumps, cans, housing			1	LS		$	800,000	
	Surge Tank			1	LS		$	100,000	
	Meters (flow, pressure, power, etc.)			1	LS		$	150,000	
15 - Mechanical							**$**	**1,000,000**	
	Water/Sewer/Storm Utility improvements			1	LS		$	200,000	
	Yard piping, Valves, and Appurtenances			1	LS		$	800,000	
16 - Electrical							**$**	**3,300,000**	
	Electrical Allowance (MCC, wiring, panels)			1	LS		$	2,500,000	
	Standby generator			1	LS		$	800,000	
17 - I&C							**$**	**2,500,000**	
	I&C/SCADA/Programming Allowance						$	2,500,000	

ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Consumables							**$**	**157,000**	
	Equipment			2%		$1,050,000	$	21,000	2% of Division 11
	Mechanical			2%		$1,000,000	$	20,000	2% of Division 15
	Electrical			2%		$3,300,000	$	66,000	2% of Division 16
	Instrumentation			2%		$2,500,000	$	50,000	2% of Division 17
Power Costs							**$**	**1,664,000**	
	Electricity Requirement	1,769	hp	10,401,509	kWh	$0.16	$	1,664,000	
						TOTAL ANNUAL O&M COSTS	**$**	**1,821,000**	

Table C-14. Cost Estimate Details: PS-OPI, Purified Water Pump Station from San José AWPF to LGRP to convey up to 10 mgd



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-OPI. Purified water from San José AWPF to LGRP

Flow	**6,945**	**gpm**
TDH	**375**	**feet**
Horsepower	**1,113**	**hp**

Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor

Date: 2/25/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	800,000	
2 - Sitework	$	1,350,000	
3 - Concrete	$	780,000	
11 - Equipment	$	550,000	
15 - Mechanical	$	550,000	
16 - Electrical	$	1,750,000	
17 - Instrumentation and Control	$	1,500,000	
Raw Construction Subtotal	**$**	**7,280,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,820,000	
		Construction Cost Subtotal	**$**	**9,100,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	410,000	
	15%	Overhead and Profit	$	1,370,000	
		Total Construction Cost	**$**	**10,880,000**	
	15%	Owner's Reserve for Change Orders	$	1,630,000	
	15%	Engineering Services (Design)	$	1,630,000	
	13%	Construction Management	$	1,410,000	
	12%	Engineering Services During Construction	$	1,310,000	
		TOTAL CAPITAL COST	**$**	**16,860,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**800,000**	
	Mobilization/Demobilization	10%	1	LS		**$**	**648,000**	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,350,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	350,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	150,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	200,000	
	Landscaping and irrigation		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 780,000**	
	Structural Concrete	18 inch	1	LS		$ 200,000	
	Vaults	12 inch	1	LS		$ 100,000	
	Equipment slabs	12 inch	1	LS		$ 75,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 125,000	
	CMU Building	25 X 40 foot	1	LS		$ 200,000	
11 - Equipment						**$ 550,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 400,000	
	Surge Tank		1	LS		$ 50,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 550,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 150,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 400,000	
16 - Electrical						**$ 1,750,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,250,000	
	Standby generator		1	LS		$ 500,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 87,000**	
	Equipment		2%		$550,000	$ 11,000	2% of Division 11
	Mechanical		2%		$550,000	$ 11,000	2% of Division 15
	Electrical		2%		$1,750,000	$ 35,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 1,047,000**	
	Electricity Requirement	1,113 hp	6,542,353	kWh	$0.16	$ 1,047,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,134,000**	

Brown AND Caldwell

Appendix A-11: Flexible Implementation of Potable Reuse, via Palo Alto AWPF

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Brown AND Caldwell

75 E Santa Clara Street, Suite 375
San José, CA 95113
T: 408.703.2535

Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC internal)

Contract no.: A4120A

Appendix A-11

Subject: Flexible Implementation of Potable Reuse – via Palo Alto AWPF

Date: May 5, 2021

To: David Tucker, Valley Water, Project Manager

From: Jenny Gain, P.E., Brown and Caldwell, Consultant Team Project Manager

Prepared by: Rene Guillen, P.E., Brown and Caldwell
California License C83467

Curtis Lam, P.E., HydroScience Engineers
California License C59049

Reviewed by: Adam Zacheis, P.E., Brown and Caldwell
California License C65696

Melanie Holmer, P.E., Brown and Caldwell
California License C63236

Limitations:

This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell (BC) dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Table of Contents

Section 1: Introduction 2
Section 2: Project Characteristics 4
2.1 Treatment Capacity Assumptions 5
2.2 Treatment Level 6
Section 3: Palo Alto Flex Scenarios 7
3.1 GWR Flex 7
3.2 RWA Flex 14
3.3 TWA Flex 19
3.4 Flex Scenario Cost Comparison 24
Section 4: Pipeline Sizing Cost Evaluation 26
Section 5: Considerations for Next Steps 27
Attachment A: TWA Demand Assessment A-1
Attachment B: Palo Alto Flex Scenario Cost Estimates B-1
Attachment C: Palo Alto Pipeline Sizing Cost Analysis C-1

List of Figures

Figure 1-1. Flexible implementation involves advancing a near-term GWR project designed and constructed to enable potential future expansion 3
Figure 2-1. Assumed source water flow rate and production capacities for flex implementation 5
Figure 2-2. AWPF process flow diagram for the near-term project and GWR Flex 6
Figure 2-3. AWPF process flow diagram for RWA Flex 6
Figure 2-4. AWPF process flow diagram for TWA Flex 7
Figure 3-1. AWPF site location, Palo Alto alternative at LATP 8
Figure 3-2. Site layout for Palo Alto GWR Flex 9
Figure 3-3. Map of Palo Alto near-term project, GWR Flex facilities and delivery point (LGRP) 12
Figure 3-4. Site layout for Palo Alto RWA Flex 15
Figure 3-5. Map of Palo Alto RWA Flex facilities and delivery points (LGRP and Rinconada WTP) 18
Figure 3-6. Map of Palo Alto TWA Flex facilities and delivery points (LGRP and potable distribution connections) 20
Figure 3-7. Site layout for Palo Alto TWA Flex 21
Figure 3-8. Estimated capital costs of Palo Alto flexible implementation scenarios 25
Figure 3-9. Estimated O&M costs of Palo Alto flexible implementation scenarios 25
Figure 4-1. Facility locations, delivery points, and alignments for TWA Flex using pipelines tapered in diameter from the Palo Alto AWPF to LGRP 28

List of Tables

Table 3-1. Palo Alto GWR Flex Project Elements 11

Table 3-2. Estimated Costs for Palo Alto GWR Flex 13

Table 3-3. Palo Alto RWA Flex Project Elements 17

Table 3-4. Estimated Costs for Palo Alto RWA Flex 19

Table 3-5. Palo Alto TWA Flex Project Elements 23

Table 3-6. Estimated Costs for Palo Alto TWA Flex 24

Table A-1. Potential TWA Deliveries along the Palo Alto GWR Alignment A-3

Table B-1. Overview of Capital and Annual O&M Costs for Palo Alto Flex Scenarios B-3

Table B-2. Cost Estimate Details: Palo Alto AWPF for GWR Flex B-4

Table B-3. Cost Estimate Details: Palo Alto AWPF for RWA Flex B-10

Table B-4. Cost Estimate Details: Palo Alto AWPF for TWA Flex B-15

Table B-5. Cost Estimate Details for PL-7 ALT: 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP B-23

Table B-6. Cost Estimate Details for Rinconada Extension: 36-inch Purified Water Pipeline from LGRP to Rinconada WTP B-24

Table B-7. Cost Estimate Details for DP5 PL (SJW TWA): 16-inch Purified Water Pipeline from GWR Alignment to SJ Water Campbell Delivery Point B-25

Table B-8. Cost Estimate Details for DP6 PL (Palo Alto TWA): 12-inch Purified Water Pipeline from GWR Alignment to Palo Alto Delivery Point B-26

Table B-9. Cost Estimate Details for DP7 PL (Mountain View/Whisman TWA): 12-inch Purified Water Pipeline from GWR Alignment to Mountain View Whisman Delivery Point B-27

Table B-10. Cost Estimate Details for DP8 PL (Sunnyvale/Mary TWA): 12-inch Purified Water Pipeline from GWR Alignment to Sunnyvale Mary Delivery Point B-28

Table B-11. Cost Estimate Details for DP8 PL (Sunnyvale TWA): 12-inch Purified Water Pipeline from GWR Alignment to Sunnyvale/Wolfe Evelyn/Central Delivery Point B-29

Table B-12. Cost Estimate Details for DP10/11 PL (Santa Clara TWA): 30-inch Purified Water Pipeline from GWR Alignment to Santa Clara Jenny Strand Park/ VW Delivery Point B-30

Table B-13. Cost Estimate Details for PS-5: Purified Water Pump Station (up to 10 mgd) from Palo Alto AWPF to LGRP (Near-Term GWR Project) B-31

Table B-14. Cost Estimate Details for PS-5: Purified Water Pump Station (Flexible Expansion, up to 24 mgd) from Palo Alto AWPF to LGRP (GWR Flex) B-33

Table B-15. Cost Estimate Details for Rinconada RWA Booster Pump Station: Purified Water from LGRP to Rinconada WTP (RWA Flex) B-35

Table B-16. Lifecycle Unit Costs for Palo Alto 10 mgd Flex Near-Term GWR Project B-37

Table C-1. Overview of Costs for Various Palo Alto Pipeline Diameter Options C-3

Table C-2. Cost Estimate Details: PL-5, 36-inch Effluent Pipeline from Palo Alto RWQCP to Palo Alto AWPF .C-4

Table C-3. Cost Estimate Details: PL-6, 36-inch Effluent Pipeline from Sunnyvale WPCP to Palo Alto AWPF .C-5

Table C-4. Cost Estimate Details: PL-7, 48-inch Purified Water Pipeline from Palo Alto AWPF to LGRP..........C-6

Table C-5. Cost Estimate Details: PL-7, 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP..........C-7

Table C-6. Cost Estimate Details: PL-7, 24-inch Purified Water Pipeline from Palo Alto AWPF to LGRP..........C-8

Table C-7. Cost Estimate Details: PL-7 Alternative, 24-inch Purified Water Pipeline from Palo Alto AWPF to LGRP..........C-9

Table C-8. Cost Estimate Details: PL-7 Alternative, 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP..........C-10

Table C-9. Cost Estimate Details: PS-3, Effluent Pump Station from Palo Alto RWQCP to Palo Alto AWPF...C-11

Table C-10. Cost Estimate Details: PS-4, Effluent Pump Station from Sunnyvale WPCP to Palo Alto AWPF.C-13

Table C-11. Cost Estimate Details: PS-5 (10 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP..........C-15

Table C-12. Cost Estimate Details: PS-5 (24 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP..........C-17

Table C-13. Cost Estimate Details: PL-5, 30-inch Effluent Pipeline from Palo Alto RWQCP to Palo Alto AWPF..........C-19

Table C-14. Cost Estimate Details: PL-6, 24-inch Effluent Pipeline from Sunnyvale WPCP to Palo Alto AWPF..........C-20

Table C-15. Cost Estimate Details: PL-7, 30-inch Purified Water Pipeline from Palo Alto AWPF to LGRP.....C-21

Table C-16. Cost Estimate Details: PS-3 (12 mgd), Purified Water Pump Station from Palo Alto RWQCP to Palo Alto AWPF..........C-22

Table C-17. Cost Estimate Details: PS-4 (8 mgd), Purified Water Pump Station from Sunnyvale WPCP to Palo Alto AWPF..........C-24

Table C-18. Cost Estimate Details: PS-5 (16 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP..........C-26

List of Abbreviations

AF	acre-foot/acre-feet
AFY	acre-feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
CIP	clean in place
CoRe Plan	Countywide Water Reuse Master Plan
County	Santa Clara County
ENR	Engineering News Record
FAT	full advanced treatment
ft	foot/feet
gpm	gallon(s) per minute
GWR	groundwater recharge
in	inch/inches
LGRP	Los Gatos recharge ponds system
M	million(s)
mgd	million gallons per day
O&M	operations and maintenance
O_3-BAC	ozone-biologically active carbon
P3	public-private partnership
PL	pipeline
PS	pump station
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWA	raw water augmentation
RWQCP	Palo Alto Regional Water Quality Control Plant
SFPUC	San Francisco Public Utilities Commission
SJW	San Jose Water[1]
TDH	total dynamic head
TM	technical memorandum
TWA	treated water augmentation
UF	ultrafiltration
UV/AOP	ultraviolet/advanced oxidation process
VW	Valley Water
WPCP	Sunnyvale Water Pollution Control Plant
WTP	Water Treatment Plant

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[1] San Jose Water does not use an accent in their name, though City of San José does.

PREFACE: A LIVING DOCUMENT

The Countywide Water Reuse Master Plan (CoRe Plan) is envisioned to be a living document to support future decision-making related to Valley Water's recycled (non-potable reuse) and purified water (potable reuse) programs. As direct potable reuse (DPR) regulations and other influencing factors/conditions (e.g., advances in treatment technologies) continue to evolve and fundamentally change the basis of projects, Valley Water will review and assess such updates relative to the CoRe Plan. As described here, the adaptability incorporated into Valley Water's approach is already being tested and demonstrated.

As Valley Water and its project team were finalizing this CoRe Plan, the State Water Resources Control Board's Division of Drinking Water released an initial draft of DPR regulations on March 22, 2021. With initial draft regulations becoming available after a multi-year effort to complete the CoRe Plan—including development of preliminary treatment trains for DPR portfolios (both raw water augmentation and treated water augmentation) and a regulatory compliance assessment—Valley Water and its project team performed a cursory review of the initial draft regulations and found the anticipated DPR requirements identified in the CoRe Plan adhere closely to those in the draft regulations. Significant elements of the draft regulation include:

- **Technical, managerial, and financial (TMF) capacity**: The draft regulations significantly increase required TMF capacity for DPR projects and clarify the State Board's proposed approach for evaluating TMF capacity of a DPR project's responsible agency (e.g., Valley Water) and respective project partners. The State Board will evaluate TMF capacity across multiple domains, including funding continuity, interagency agreements, staffing, and operator certification. Compliance will require documentation through an extensive suite of reports, programs, and plans beyond those currently required for indirect potable reuse (IPR) projects.
- **Chemical control**: The draft regulations include prescriptive requirements for additional treatment (including design, operation, and performance), expanded monitoring requirements, significant expansion of source control programs, and more stringent control and response limits.
- **Pathogens**: DPR will require significantly higher log reduction value requirements than IPR for all pathogens. The regulations further clarify how those values must be met in terms of the number, types, and diversity of barriers, as well as protocols for validation and continuous verification of the performance of each treatment process.
- **Monitoring and control**: the draft regulations require a higher degree of monitoring (i.e., frequency, locations, and range of contaminants) and more stringent operational control (e.g., automatic diversions and shutdowns) to prevent distribution of water that is not compliant with requirements.

Because many of these requirements were anticipated, the DPR treatment trains included in the CoRe Plan will comply with most of the draft requirements without significant alterations to the process trains. However, the draft regulations have a larger impact on the regulatory compliance assessment given the clarification on several topics previously less defined, such as enhanced source control and TMF capacity requirements.

Valley Water will continue to monitor DPR regulatory development and associated impacts to the CoRe Plan and will provide necessary updates to maintain the efficacy of this planning document for future potable reuse implementation.

Section 1: Introduction

The Countywide Water Reuse Master Plan (CoRe Plan) evaluates reuse opportunities—individual projects and collective portfolios that combine projects—and considers implementation pathways to increase the region's water supply reliability through potable reuse over a planning horizon of 2040. As an outcome of that work, this planning-level document considers several scenarios for advancing potable reuse projects identified in the CoRe Plan with some variations (namely production capacity) and repackaging. The scenarios build on Valley Water's (VW) intention to design and construct a near-term project using a flexible implementation approach that can support potential reuse expansion in the future.

For this planning-level effort, the following concepts and terms are applied throughout this technical memorandum (TM):

- **Flexible implementation approach** – Refers to a prudent planning approach to design and construct a near-term groundwater recharge (GWR) project (anticipated by 2028) with sufficient flexibility to support potential future expansion. Key aspects of this approach include the following.
  - VW plans to construct an advanced water purification facility (AWPF) with a production capacity of 10 million gallons per day (mgd) for GWR. The near-term project involves design and construction of a pipeline to convey purified water from the AWPF to the Los Gatos Recharge Ponds system (LGRP, or LGRS[2]) for GWR via surface spreading.
  - The purpose of using a flexible implementation approach is to consider design aspects at the outset that can support potential future expansion of the 10-mgd facility by increasing the production capacity by an additional 14 mgd, for a total capacity of up to 24 mgd.
  - Potential future expansion may involve:
    1. Increases to treatment facility hydraulic capacity and purified water deliveries,
    2. Opportunities for future implementation of direct potable reuse (DPR) once the state issues applicable regulations, and
    3. Enhancements of treatment processes as applicable based on reuse type or changes in regulatory requirements.
- **Flexible expansion** – Refers to potential expansion of the near-term project to provide additional purified water treatment capacity in the future.
- **GWR, raw water augmentation (RWA), and treated water augmentation (TWA) Flex** – Refer to the three scenarios evaluated for flexible expansion (Figure 1-1). Each involves increasing the production capacity of the near-term 10-mgd AWPF, resulting in up to 24 mgd of purified water for the following types of reuse:
  - GWR, referred to as *GWR Flex*
  - GWR and RWA, referred to as *RWA Flex*
  - GWR and TWA, referred to as *TWA Flex*

---

[2] Valley Water's system of recharge ponds located in Los Gatos are referred to as Los Gatos Recharge Ponds (LGRP) system in past documents. In recent documents and going forward, Valley Water is referring to the same facility as Los Gatos recharge system (LGRS).

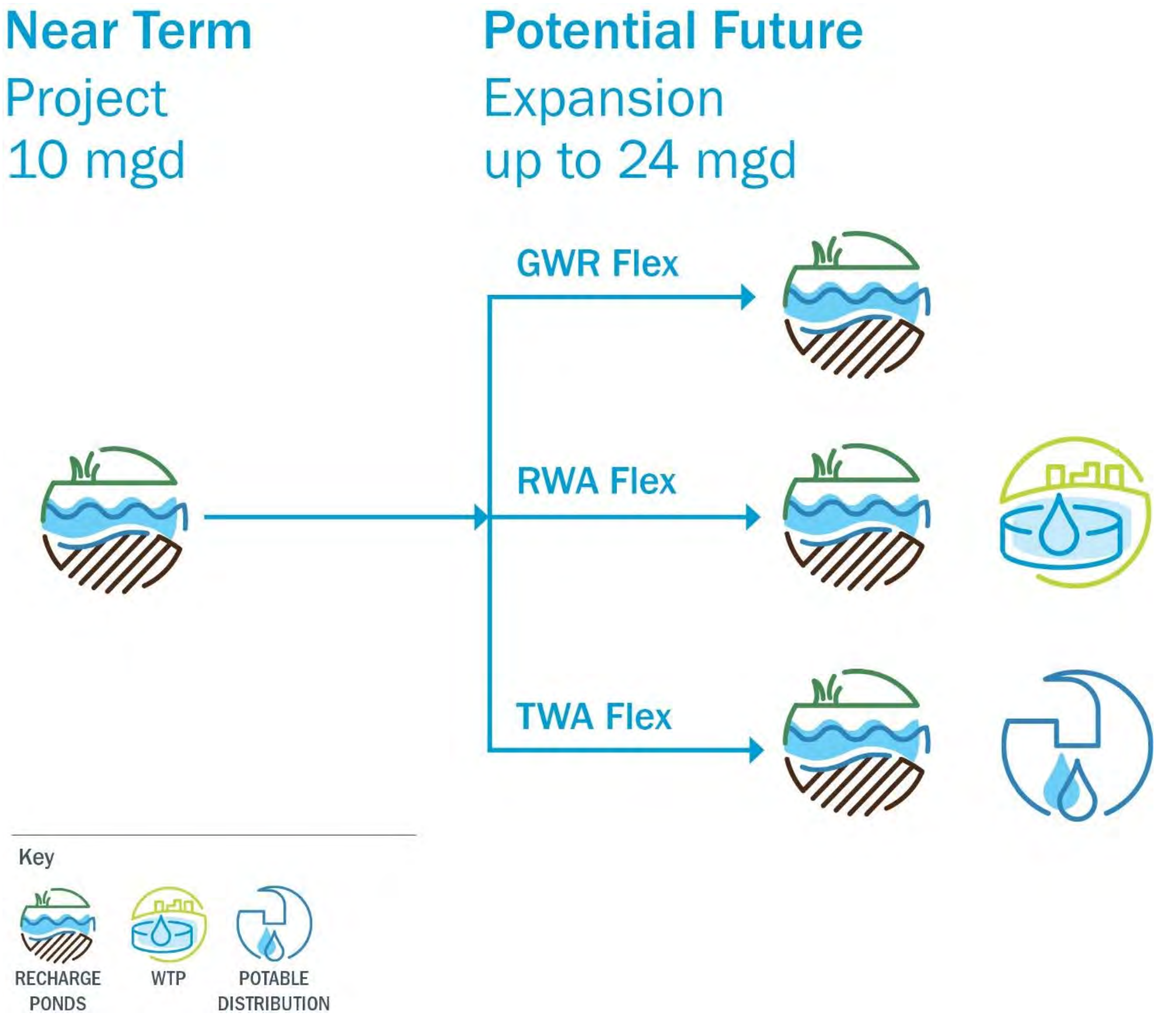

Figure 1-1. Flexible implementation involves advancing a near-term GWR project designed and constructed to enable potential future expansion

While the near-term project is definitively GWR, various conditions, events, or processes may trigger, or hinder, future expansion to GWR, RWA, or TWA Flex, such as reliability of other water supplies[3]; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand. Flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities.

The scope of this TM involves teasing apart and reassembling Class 5 cost estimates developed for the CoRe Plan based on the smaller production capacity for the near-term project (i.e., 10 mgd instead of 24 mgd) and characteristics of the flexible expansion under each scenario considered. The cost estimates are based on vendor quotes specific to proposed facilities, historical construction estimates, historical costs, and professional experience with similar projects. Some operations costs scale proportionally from the 24 mgd estimates used in the CoRe Plan to 10 mgd, such as the costs of purchasing source water supply for reuse and operating reverse osmosis concentrate (ROC) management. Cost estimate assumptions and calculations are summarized in Attachment B.

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[3] Factors that influence supply reliability may include, but are not limited to, water supply agreements/contracts, hydrologic conditions (i.e., droughts, climate change), evolving and new regulations, natural disasters (e.g., earthquakes, wildfires), and/or human-induced threats.

The CoRe Plan appendices complement this TM with more detailed information. Relevant appendices include the following (Appendices D, E, and F are less relevant):

- **Appendix A-1:** Feasible Project Portfolios
- **Appendix A-2:** Compendium of flow assessments, facility design capacity, and annual yield calculations
- **Appendix A-3:** Treatment facilities' design criteria and sizing calculations
- **Appendix A-4:** Process flow diagrams and site layouts
- **Appendix A-5:** Basis of costs for project elements (i.e., inputs, assumptions, methods, and sources)
- **Appendix A-6:** Conceptual estimates for project elements' costs (i.e., line-item costs for AWPFs, pump stations, pipelines, and system interties)
- **Appendix A-7:** Expanded evaluation and risk assessment
- **Appendix A-8:** TWA pre-screening analysis
- **Appendix A-9:** Evaluation of Onsite Reuse in Santa Clara County
- **Appendix A-10:** Flexible Implementation of Potable Reuse – via San José AWPF
- **Appendix B:** Regulatory compliance
- **Appendix C:** Hydraulic modeling
- **Appendix G:** ROC management strategies

Section 2: Project Characteristics

Some project components, such as treatment equipment for purification processes related to GWR and purified water storage/pump station, can be sized according to the near-term project's capacity (10 mgd)[4] and expanded in the event VW decides to increase the capacity in the future. Yet, the flexible implementation approach requires beginning with the end in mind, such that the near-term project is designed and constructed to enable future expansion as contemplated under the GWR, RWA, and TWA Flex scenarios.

Each future expansion scenario considered in this TM is assumed to increase capacity of the 10-mgd AWPF to 24 mgd and treat all flow to the highest quality required by the delivery points (reuse type). For example, TWA Flex would treat all flow from the 24 mgd facility to TWA quality, even though part of the flow would be delivered to LGRP. Potential future expansion is critically linked to the following aspects of the near-term project:

- **Pipelines to convey 24 mgd of purified water from the AWPF to LGRP** while the CoRe Plan includes 48-inch diameter pipe for conveyance, the Flex scenarios reduce that to 36-inch diameter pipe. This decision balances the ability to convey up to 24 mgd of flow in the future.
- **ROC management facilities** sized to manage the anticipated volume of 4.24 mgd ROC from an expanded 24-mgd AWPF. In the near-term, the 10 mgd AWPF is estimated to produce approximately 1.76 mgd ROC. Estimated volumes and costs for ROC management are based on "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD.
- **Site layout and footprint for a 24 mgd capacity AWPF** with sufficient space for the respective treatment processes, process building footprint, and facilities to meet requirements of anticipated reuse types.

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[4] The annual energy demand related to the near-term 10 mgd project with source water originating from the Palo Alto RWQCP is estimated at 20,343 MWh/yr.

That is, to implement either RWA Flex or TWA Flex in the future, treatment is anticipated to require additional processes for the full 24 mgd regardless of amount used for GWR at any given time. In addition, the site layout requires sufficient space to considering the turning radius of trucks that require site access for activities such as chemical deliveries, emergency services, and construction of the expanded facility.

- **Land acquisition and site preparation** to accommodate the 24 mgd AWPF's site layout and footprint

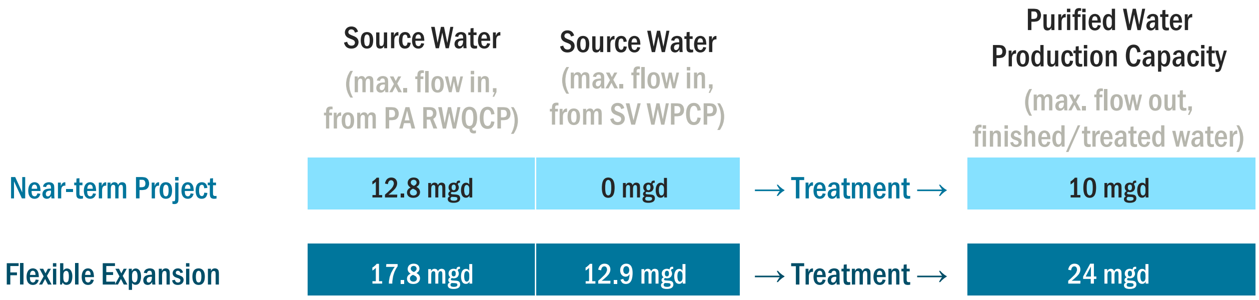
It is assumed that the AWPF would shut down during construction to expand the facility and that membranes from the near-term project are feasible for continued use (as their life cycle allows) in a future RWA or TWA application.

The reuse treatment facilities are distinguished by the following characteristics:

- **Source water** refers to the origin (agency/facility) of wastewater for reuse. For this evaluation, source water will be from the Palo Alto Regional Water Quality Control Plant (RWQCP), possibly in combination with the Sunnyvale Water Pollution Control Plant (WPCP). An evaluation of source water flows is included in Appendices A-1 and A-2 of the CoRe Plan.
- **Treatment level (or type of reuse)** refers to treatment extent based on type of reuse (GWR via surface spreading, RWA, and TWA). Minimum treatment levels include:
  - For GWR: Full advanced treatment (FAT), as required by VW, and post-treatment stabilization
  - For RWA: FAT along with ozone-biologically active carbon (O_3-BAC), post-treatment stabilization and free chlorine disinfection
  - For TWA: FAT, O_3-BAC, free chlorine disinfection, chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time
- **Delivery point** refers to the facility/location where purified water is delivered for reuse. Ultimate delivery points include:
  - For GWR: LGRP
  - For RWA: Rinconada Water Treatment Plan (WTP)
  - For TWA: Potable (treated) water distribution system connections, as described in Attachment A of this TM

2.1 Treatment Capacity Assumptions

Figure 2-1 summarizes treatment capacity assumptions for the near-term project and flexible expansion (GWR, RWA, and TWA Flex scenarios).



	Source Water (max. flow in, from PA RWQCP)	Source Water (max. flow in, from SV WPCP)		Purified Water Production Capacity (max. flow out, finished/treated water)
Near-term Project	12.8 mgd	0 mgd	→ Treatment →	10 mgd
Flexible Expansion	17.8 mgd	12.9 mgd	→ Treatment →	24 mgd

Figure 2-1. Assumed source water flow rate and production capacities for flex implementation

2.2 Treatment Level

Consistent with the CoRe Plan, this TM assumes GWR requires FAT processes, including membrane filtration, reverse osmosis (RO), and ultraviolet/advanced oxidation process (UV/AOP), as shown in the process flow diagram in Figure 2-2.

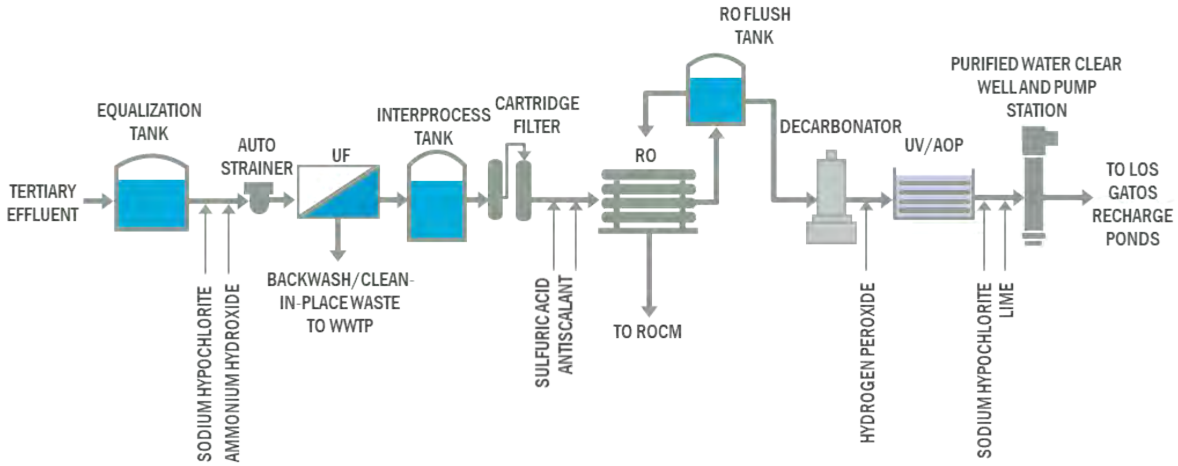


Figure 2-2. AWPF process flow diagram for the near-term project and GWR Flex

To meet anticipated regulatory requirements, RWA Flex is likely to require FAT as a minimum baseline level of treatment, along with O_3-BAC pretreatment and free chlorine disinfection for pathogen and chemical control (blue dashed line in the process flow diagram in Figure 2-3).

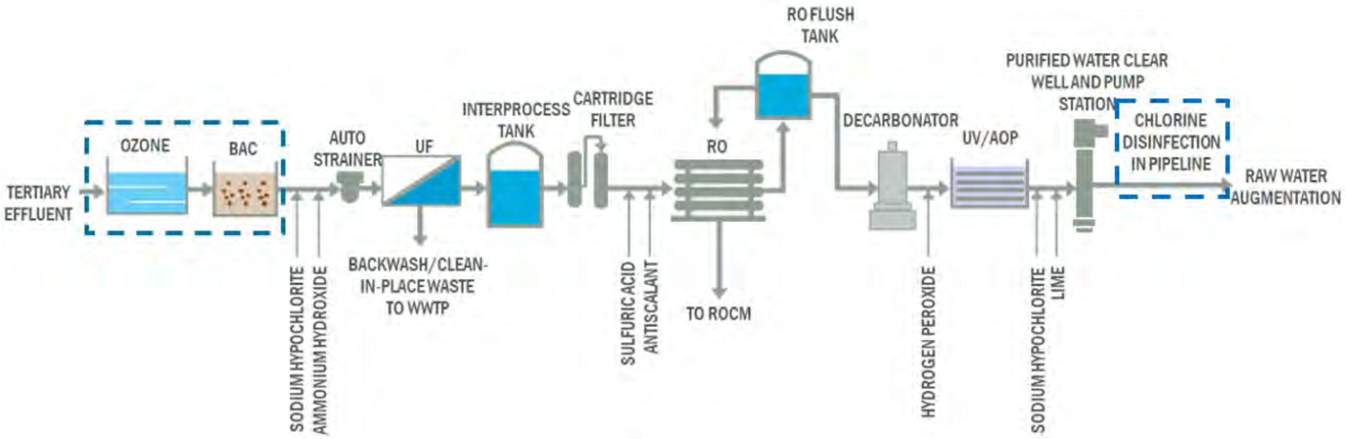


Figure 2-3. AWPF process flow diagram for RWA Flex

TWA Flex is anticipated to require O_3-BAC upstream of membrane filtration. In addition, the downstream end is anticipated to require chorine disinfection, air stripping facilities, and an eight-hour clearwell (blue dashed line in Figure 2-4). With ample pathogen reduction in the treatment processes for RWA, the TWA treatment train focuses on additional chemical control and/or chemical peak attenuation, post-treatment stabilization, temperature, and barriers to allow appropriate response time. This treatment train considers the potential to demonstrate higher pathogen log reduction value for the upstream wastewater treatment plant or RO, if needed.

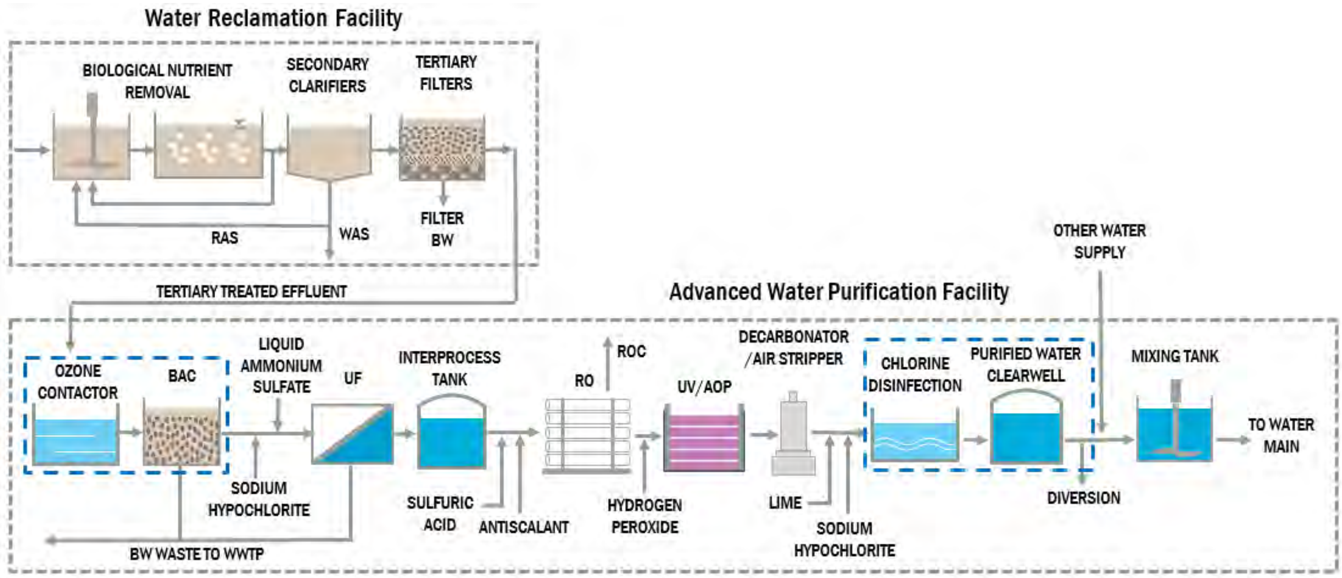


Figure 2-4. AWPF process flow diagram for TWA Flex

Details and assumptions of the treatment processes, including pathogen reduction and chemical control, are summarized in Appendix A-1 of the CoRe Plan.

Section 3: Palo Alto Flex Scenarios

As described above, three flex scenarios are potable reuse project elements from the CoRe Plan that are resized and repackaged to allow for potential incremental expansion. These scenarios have flexible expansion capacity up to 24 mgd for GWR, RWA, or TWA. The three scenarios are described in further detail in the following sections.

3.1 GWR Flex

Palo Alto GWR Flex is premised on treating available effluent from the Palo Alto RWQCP, and from Sunnyvale WPCP if AWPF is expanded in the future, with a new AWPF located at the former Los Altos Treatment Plant (LATP)[5] site. The AWPF would produce up to 10 mgd in the near term and up to 24 mgd with potential future expansion for GWR at LGRP. Source water for the near-term project would be supplied only by the Palo Alto RWQCP. The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd.

A source water pipeline would be constructed between the Palo Alto RWQCP and the LATP site, sized to accommodate source water necessary for the future flexible expansion (17.8 mgd to produce 14 mgd of purified water). A source water pipeline from the Sunnyvale WPCP to the LATP site would only be constructed as part of the future expansion. Figure 3-1 depicts the LATP site and surrounding streets, buildings, and trails near the San Francisco Bay.

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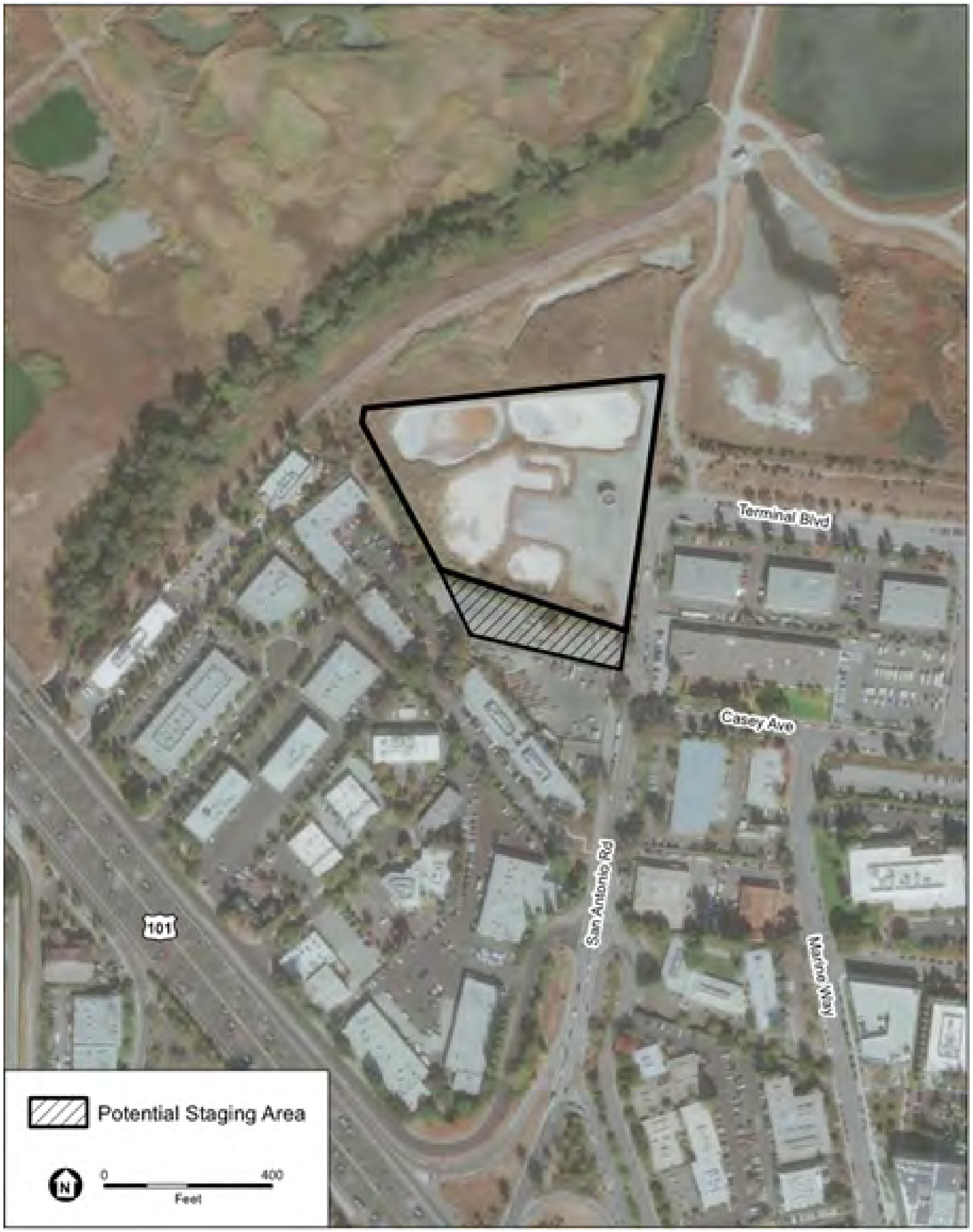
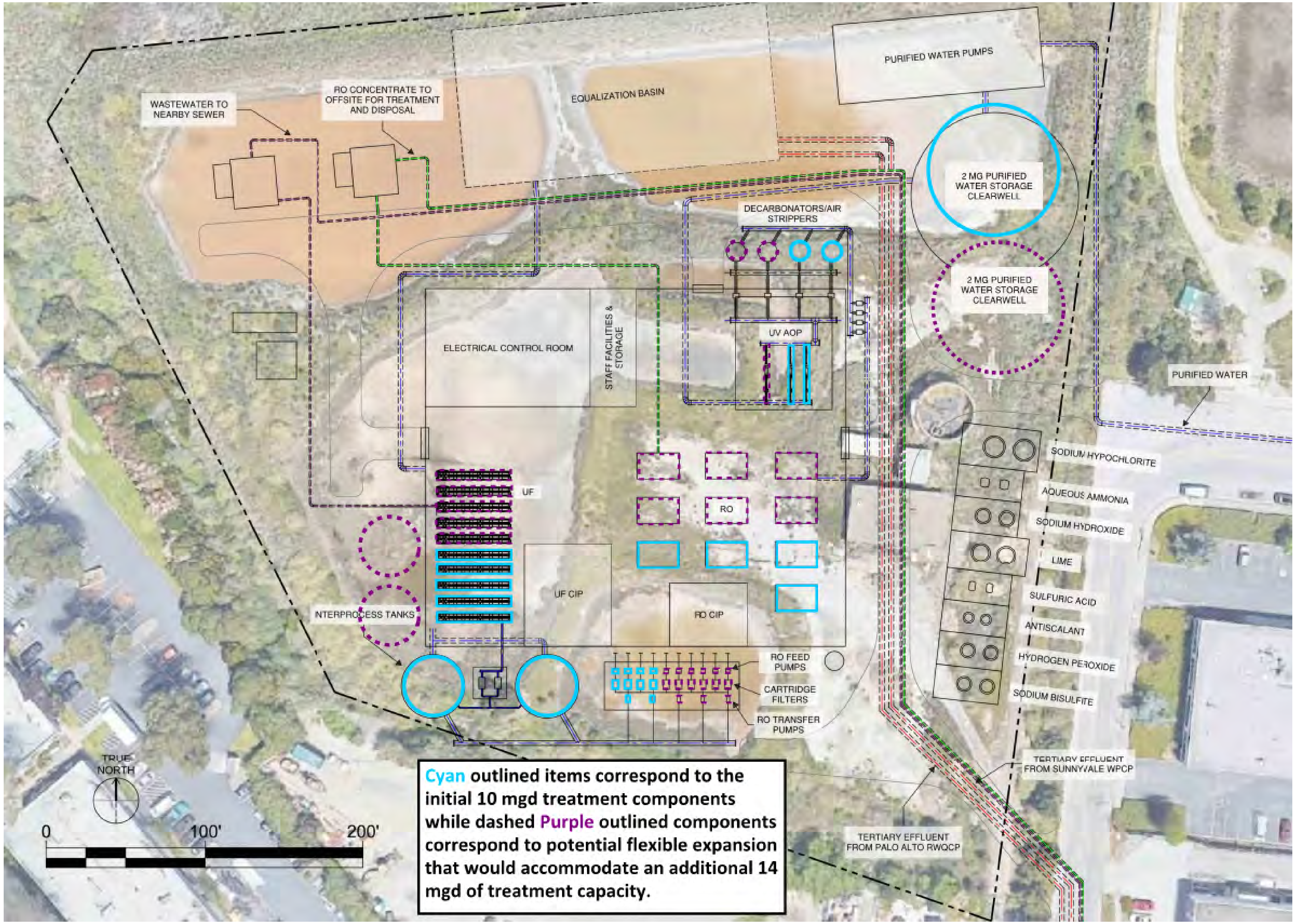
[5] Sometimes referred to as Former Los Altos Treatment Plant (FLATP) in other Valley Water references.



Source: ESA, 2020 and Google Earth, 2020

Figure 3-1. AWPF site location, Palo Alto alternative at LATP

A detailed site layout, indicating components required for the near-term project in cyan and components needed for flexible expansion to 24 mgd of capacity in purple, is shown in Figure 3-2.



Cyan outlined items correspond to the initial 10 mgd treatment components while dashed **Purple** outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity.

Figure 3-2. Site layout for Palo Alto GWR Flex

Note: CIP = clean in place, UF = ultrafiltration

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Besides a new AWPF, GWR Flex project elements include ROC management and purified water conveyance from the AWPF to LGRP and infrastructure improvements at LGRP to integrate purified water into the existing system (Table 3-1). The proposed 20-mile pipeline from the AWPF to LGRP is sized to convey up to 24 mgd of potential future flow and would traverses through highly urbanized settings with significant utilities and temporary community disruption. Infrastructure improvements at LGRP would support operational flexibility, allowing ponds to be maintained without impacting the entire complex. Conveyance and LGRP infrastructure improvements would be built as part of the near-term project and sized to accommodate flexible expansion.

A combination of flow from the Sunnyvale WPCP and Palo Alto RWQCP could provide source water to support the potential expansion to up to 24 mgd. As part of this, a new source water pipeline would connect the Sunnyvale WPCP to the Palo Alto AWPF (former LATP site). Treatment equipment and other pertinent facilities would be added to accommodate this flexible expansion capacity, as would pumps to the purified water pump station. The proposed pipeline alignment from the AWPF to LGRP is shown in Figure 3-3.

Table 3-1. Palo Alto GWR Flex Project Elements

Element		Capacity (mgd)	
Palo Alto AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump Stations		**Capacity**	**TDH (ft)**
PS-3 effluent from Palo Alto RWQCP to Palo Alto AWPF	Near-Term	12,000	100’
PS-4 effluent from Sunnyvale WPCP to Palo Alto AWPF	Flexible Expansion	8,000	100’
PS-5 purified water to LGRP	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-5 effluent from Palo Alto RWQCP to Palo Alto AWPF	Near-Term	36”	15,150’
PL-6 effluent from Sunnyvale WPCP to Palo Alto AWPF	Flexible Expansion	36”	38,820’
PL-7 purified water from Palo Alto AWPF to LGRP	Near-Term	36”	107,400’
ROC management pipeline [a]	Near-Term	18”	10,900’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (VW, 2018)		

a. *Potential future expansion requires hydraulic expansion to produce up to 24 mgd treated to GWR water quality requirements.*

b. *ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD (attached to the CoRe Plan as Appendix G)*

ft = foot/feet
gpm = gallon(s) per minute
in = inch/inches
PL = pipeline
PS = pump station
TDH = total dynamic head

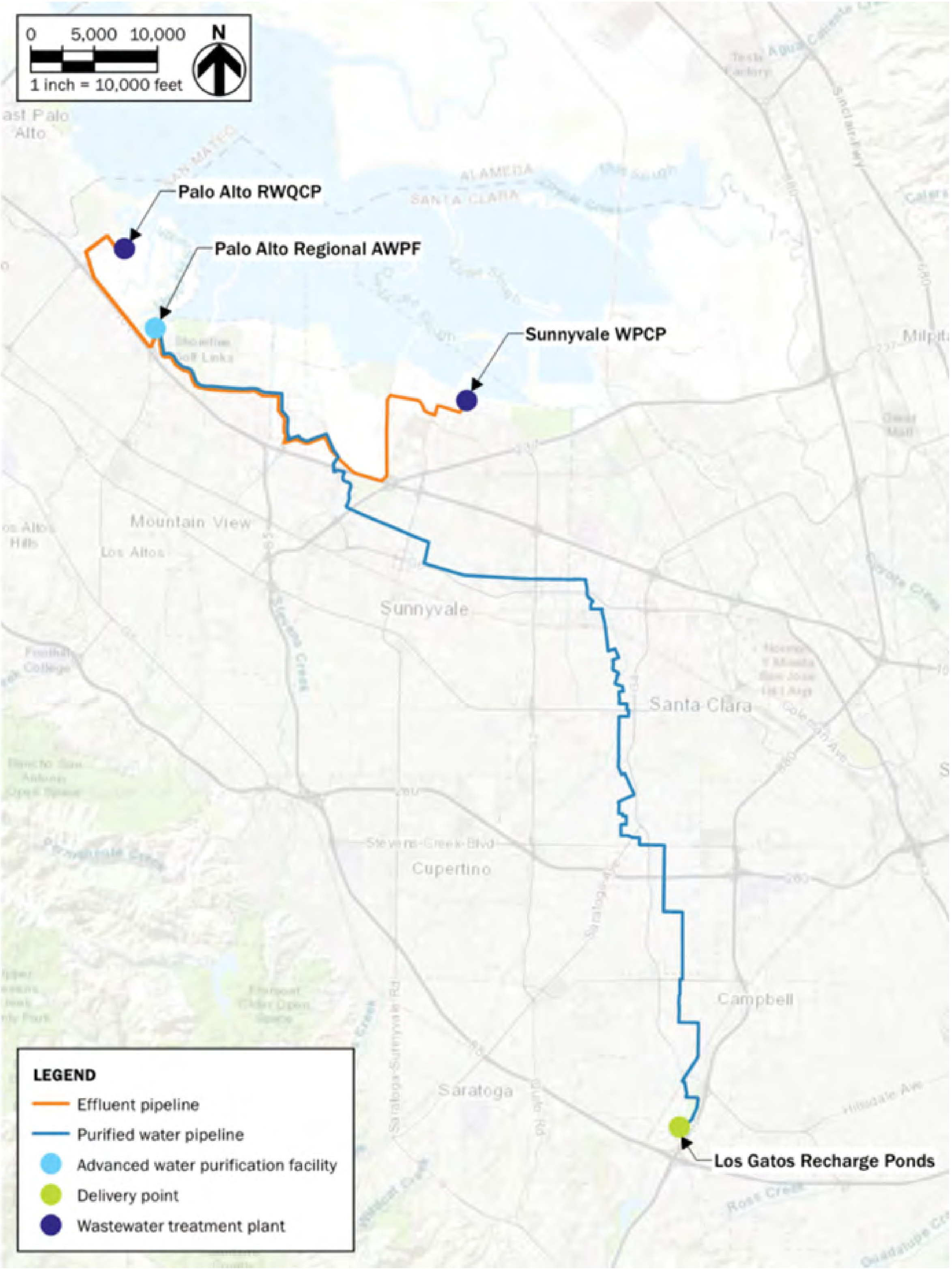


Figure 3-3. Map of Palo Alto near-term project, GWR Flex facilities and delivery point (LGRP)

Table 3-2 contains estimated capital and annual operations and maintenance (O&M) costs for GWR Flex, presented in 2019 dollars.

Table 3-2. Estimated Costs for Palo Alto GWR Flex

	Capital Cost [a] ($2019, in millions)			Annual O&M Cost [a] ($2019, in millions)		
Element	Near-Term Project (10 mgd) [b]	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)
Palo Alto AWPF	$195	$145	$340	$5.9	$7.5	$13.4
Conveyance infrastructure Effluent Pump Station (Palo Alto RWQCP to AWPF) Effluent Pipeline (Palo Alto RWQCP to AWPF) Effluent Pump Station (Sunnyvale WPCP to AWPF) Effluent Pipeline (Sunnyvale WPCP to AWPF) Purified Water Pump Station (AWPF to LGRP) Purified Water Pipeline (AWPF to LGRP) LGRP improvements Pipeline easements	$290	$95	$385	$2.5	$2.6	$5.1
Annual source water purchase	--	--	--	$1.0	$1.4	$2.4
ROC management (existing outfall) [d]	$35	--	$35	$0.7	$0.9	$1.6
Total	**$520**	**$240**	**$760**	**$10.1**	**$12.4**	**$22.5**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *The CoRe Plan includes an estimated capital cost of $200M for a 14 mgd Palo Alto AWPF (Portfolio 4). The capital cost shown here for a 10 mgd AWPF is similar due to: (i) rounding, in part, and (ii) inclusion of specific features, detailed in cost attachments, that would allow the near-term 10 mgd AWPF to accommodate future expansion.*

c. *Expansion capital and O&M costs represent the incremental cost of modifications and construction to increase the 10 mgd facility by an additional 14 mgd.*

d. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the Engineering News Record (ENR) Construction Cost Index for San Francisco.*

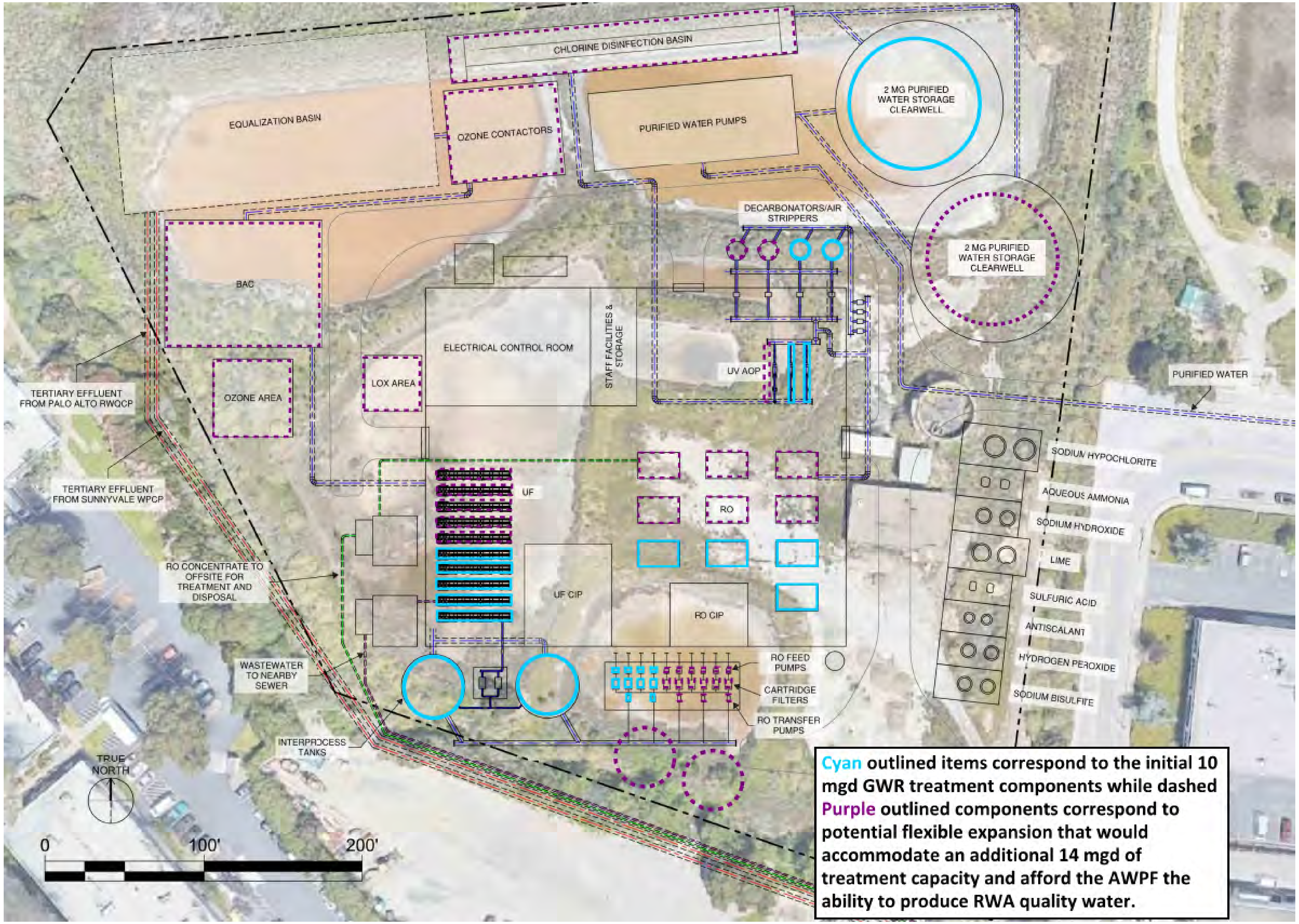
The estimated unit cost for the Palo Alto GWR Flex near-term 10 mgd project over 30-year and 100-year life cycles would be $3,600/AF and $2,700/AF, respectively. This estimate includes capital, O&M, renewal and replacement, and source water purchase and does not include flex expansion as part of the life cycle. The purified water pipeline to LGRP is sized at 36-inches for the near-term project to accommodate potential future expansion to 24 mgd. CoRe Plan portfolios use a 48-inch purified water pipeline to LGRP. For additional detail, refer to the following:

- Methodology for estimating life-cycle costs: Refer to Appendix A-5 of the CoRe Plan
- Cost tables for conveyance infrastructure that is a consistent size in the CoRe Plan and this Flex TM: Refer to Appendix A-6 of the CoRe Plan
- Tables with life-cycle cost details: See Attachment B, Table B-16

3.2 RWA Flex

Palo Alto RWA Flex is premised on treating effluent from the Palo Alto RWQCP and Sunnyvale WPCP at a new AWPF located at the LATP site. The AWPF would produce up to 10 mgd in the near term for GWR at LGRP. The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment processes/equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd.

In the future, the AWPF could be expanded by up to 14 mgd in production capacity, for a total capacity of 24 mgd for potable reuse via GWR at LGRP and/or RWA at Rinconada WTP. The expansion would involve increasing the AWPF's hydraulic capacity and adding treatment processes anticipated for forthcoming RWA requirements, such as O_3-BAC. Expansion would also require source water from the Sunnyvale WPCP. This source water would be conveyed from the Sunnyvale WPCP to the Palo Alto AWPF through a new pipeline that would need to be constructed as part of the expansion. The site layout, indicating components required for the near-term project in cyan and components needed for flexible expansion to 24 mgd of capacity in purple, is shown in Figure 3-4.



Cyan outlined items correspond to the initial 10 mgd GWR treatment components while dashed Purple outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity and afford the AWPF the ability to produce RWA quality water.

Figure 3-4. Site layout for Palo Alto RWA Flex

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RWA Flex includes the same project elements as GWR Flex, along with a new booster pump station and pipeline to convey water from the Vasona Ponds to the Rinconada WTP as part of the potential future expansion (Table 3-3). The pump station is sized to convey up to 24 mgd through a 36-inch pipe to the Rinconada WTP, same as the upstream pipeline capacity to pump to LGRP (Figure 3-5). That is, up to 24 mgd could be delivered to either Rinconada WTP or LGRP. Assuming an average delivery of 10 to 14 mgd to Rinconada WTP, the remaining 10 to 14 mgd would be delivered to LGRP. O&M costs for pumping to Rinconada WTP are based on an average flow of 12 mgd. The specific pump station location is not yet identified but assumed to be located on VW-owned property and absent of sensitive habitat. Given the proximity to the existing Vasona Pump Station, ample power is assumed to be available at the pump station

Table 3-3. Palo Alto RWA Flex Project Elements

Element		Capacity (mgd)	
Palo Alto AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump stations		**Capacity (gpm)**	**TDH (ft)**
PS-3 (effluent from Palo Alto RWQCP to AWPF)	Near-Term	12,000	100’
PS-4 (effluent from Sunnyvale WPCP to AWPF)	Flexible Expansion	8,000	100’
PS-5 (purified water to LGRP)	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Rinconada RWA Booster PS	Flexible Expansion	16,700	240’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-5 (effluent from Palo Alto RWQCP to AWPF)	Near-Term	36”	15,150’
PL-6 (effluent from Sunnyvale WPCP to AWPF)	Flexible Expansion	36”	38,820’
PL-7 (purified water from AWPF to LGRP)	Near-Term	36”	107,400’
ROC management pipeline [b]	Near-Term	18”	10,900’
Rinconada RWA extension pipeline	Flexible Expansion	36”	12,400’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (VW, 2018)		

a. *Potential future expansion requires hydraulic expansion and additional unit processes to produce up to 24 mgd treated to meet anticipated RWA water quality requirements.*

b. *ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD*

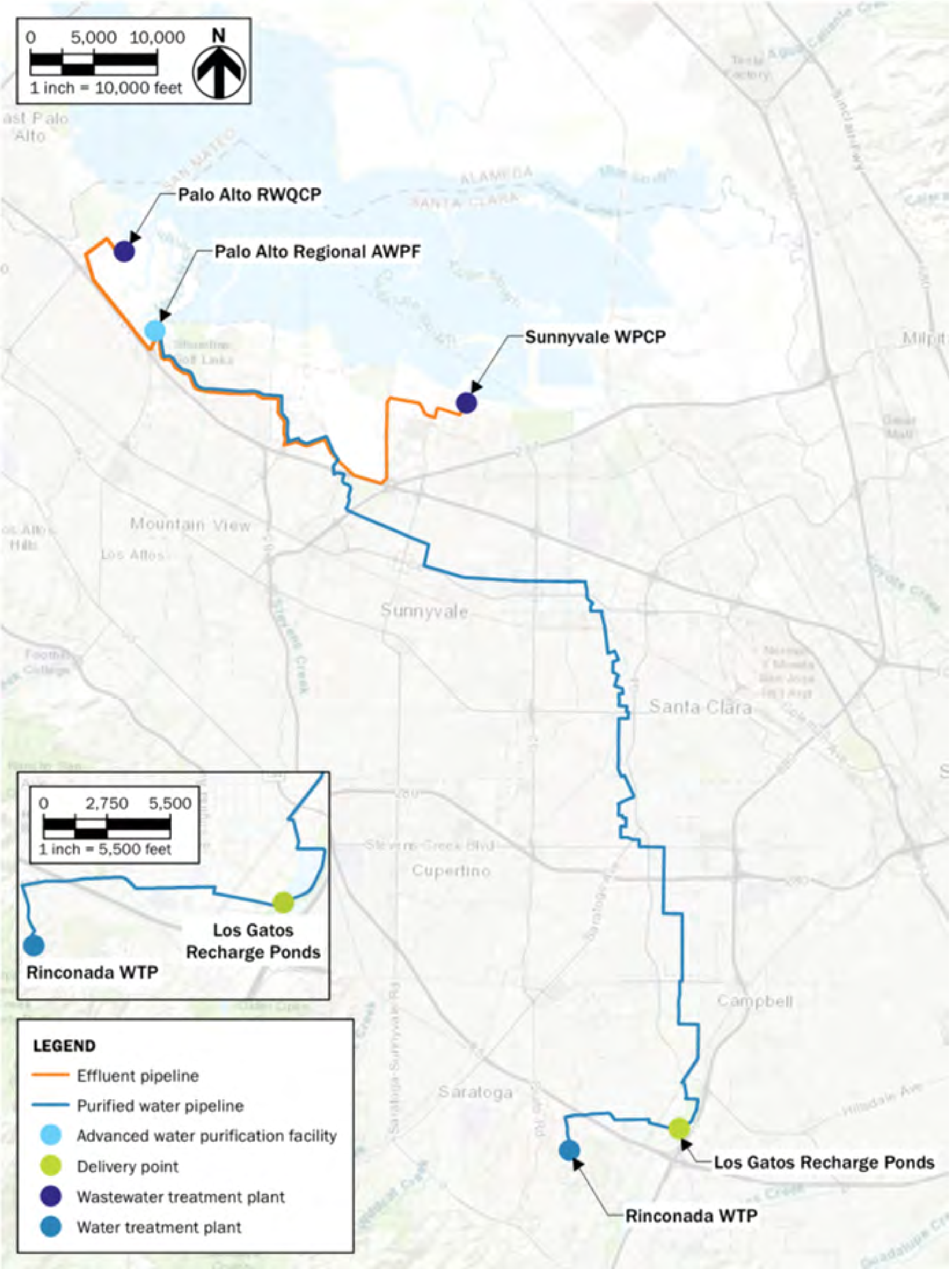


Figure 3-5. Map of Palo Alto RWA Flex facilities and delivery points (LGRP and Rinconada WTP)

Table 3-4 contains estimated capital and annual O&M costs for RWA Flex, presented in 2019 dollars. Further cost details are included in Attachment B.

Table 3-4. Estimated Costs for Palo Alto RWA Flex						
	Capital Cost [a] ($2019, in millions)			Annual O&M Cost [a] ($2019, in millions)		
Element	Near-Term Project (10 mgd) [b]	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)
Palo Alto AWPF	$195	$190	$385	$6.0	$9.8	$15.8
Conveyance infrastructure Effluent Pump Station (Palo Alto RWQCP to AWPF) Effluent Pipeline (Palo Alto RWQCP to AWPF) Effluent Pump Station (Sunnyvale WPCP to AWPF) Effluent Pipeline (Sunnyvale WPCP to AWPF) Purified Water Pump Station (AWPF to LGRP) Purified Water Pipeline (AWPF to LGRP) LGRP improvements Rinconada RWA booster PS Rinconada RWA extension PL Pipeline easements	$290	$140	$430	$2.5	$4.6	$7.1
Annual source water purchase	--	--	--	$1.0	$1.4	$2.4
ROC management (existing outfall) [d]	$35	--	$35	$0.7	$0.9	$1.6
Total [e]	**$520**	**$330**	**$850**	**$10.2**	**$16.7**	**$26.9**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *The capital cost of a 10-mgd AWPF is similar to that of a 14-mgd Palo Alto AWPF in the CoRe Plan (Portfolio 4; $200M) due to: (i) rounding, in part, and (ii) inclusion of specific features, detailed in cost attachments, to accommodate future expansion of the 10-mgd AWPF.*

c. Expansion capital and O&M costs represent the incremental cost of modifications and construction to increase the 10-mgd facility by an additional 14 mgd.

d. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.*

e. *Does not include costs for visitor center*

3.3 TWA Flex

Palo Alto TWA Flex is premised on treated effluent from the Palo Alto RWQCP and Sunnyvale WPCP at a new AWPF located at the LATP site. The AWPF would produce up to 10 mgd in the near term for GWR at LGRP.

In the future, the AWPF could be expanded by up to 14 mgd in production capacity, for a total capacity of 24 mgd for potable reuse via GWR at LGRP and/or TWA at several connections to local potable distribution systems proximate to the purified water pipeline that conveys flow from the AWPF to LGRP. These locations are shown in Figure 3-6 and described in Attachment A. The expansion would involve increasing the AWPF's hydraulic capacity and adding treatment processes anticipated for forthcoming TWA requirements, such as O_3-BAC, chlorine disinfection, air stripping facilities, and an eight-hour clearwell.

The AWPF site, corresponding buildings, and pipeline to LGRP are sized to accommodate up to 24 mgd. However, treatment processes/equipment, purified water pumps, and other pertinent facilities are sized to accommodate the near-term project capacity of 10 mgd. Expansion would also require source water from the Sunnyvale WPCP. This source water would be conveyed from the Sunnyvale WPCP to the Palo Alto AWPF through a new pipeline that would need to be constructed as part of the expansion. The site layout for near-term and flexible expansion capacities is shown in Figure 3-7.

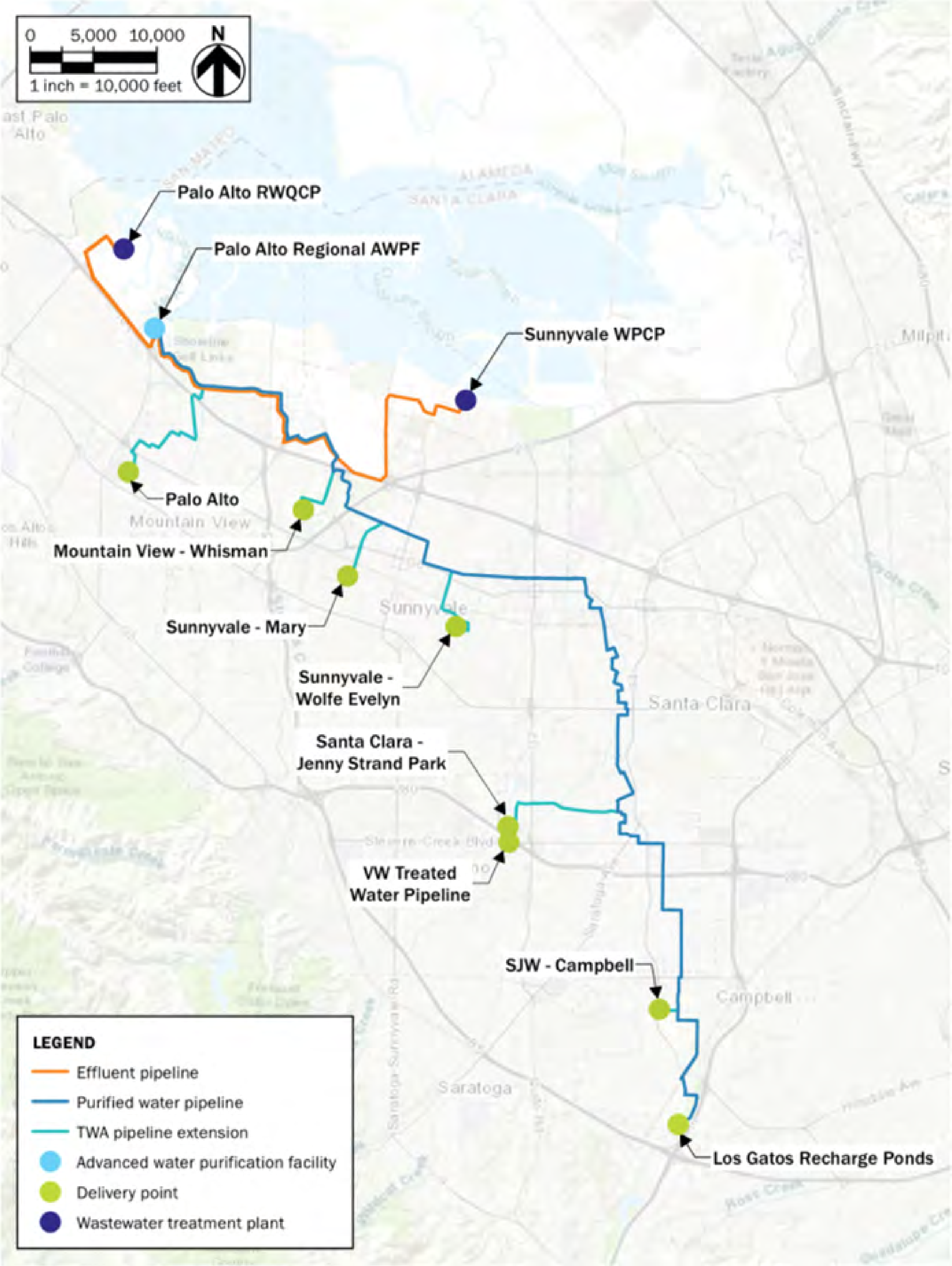
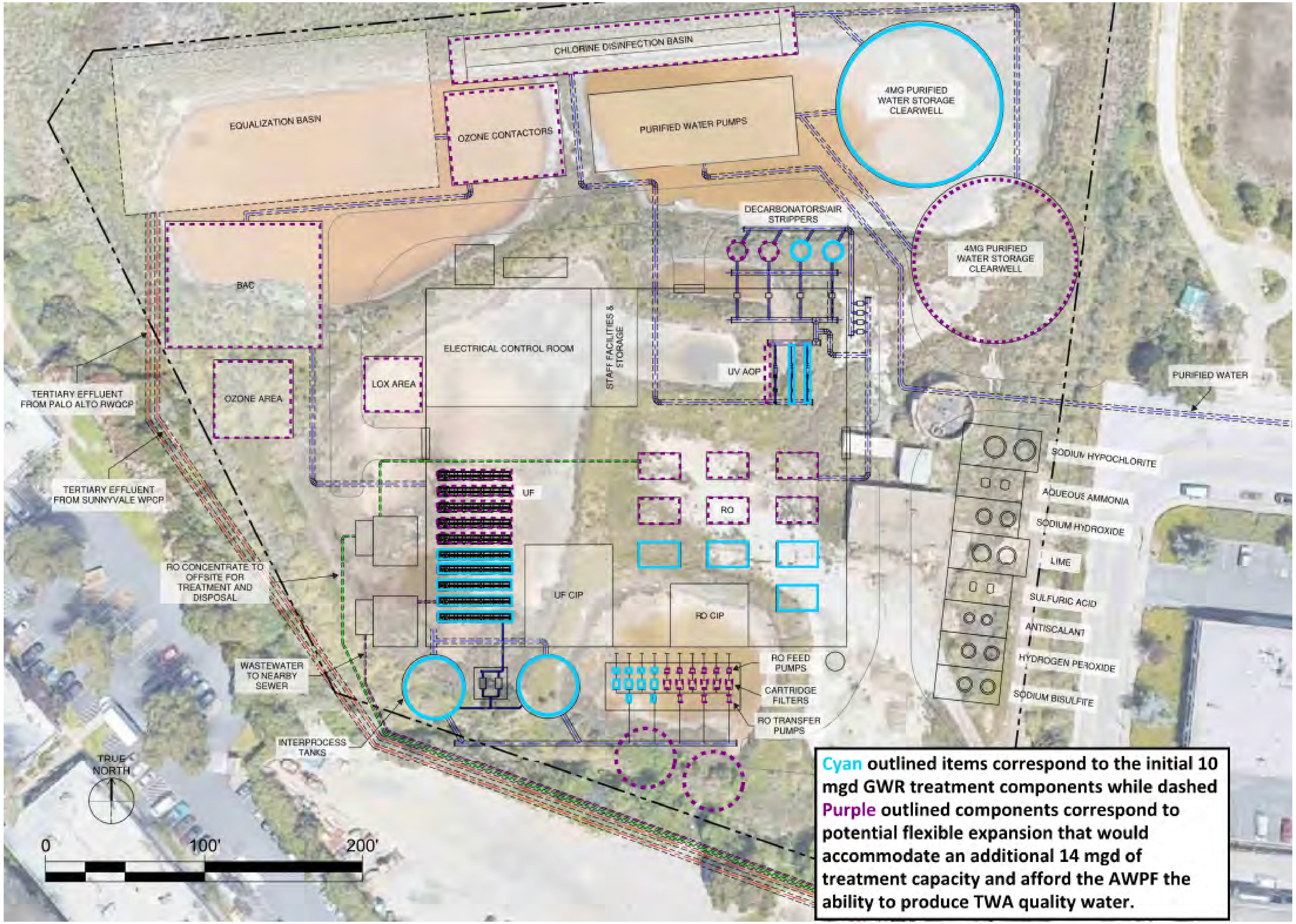


Figure 3-6. Map of Palo Alto TWA Flex facilities and delivery points (LGRP and potable distribution connections)



Cyan outlined items correspond to the initial 10 mgd GWR treatment components while dashed Purple outlined components correspond to potential flexible expansion that would accommodate an additional 14 mgd of treatment capacity and afford the AWPF the ability to produce TWA quality water.

Figure 3-7. Site layout for Palo Alto TWA Flex

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TWA Flex includes the same project elements as GWR Flex, along with seven pipelines (or turnouts) to connect the purified water pipeline to potable water distribution system delivery points. Table 3-5 summarizes the project elements associated with TWA Flex.

Table 3-5. Palo Alto TWA Flex Project Elements

Treatment		Capacity (mgd)	
Palo Alto AWPF	Near-Term	10	
	Flexible Expansion	+14 [a]	
	Total	24 [a]	
Pump stations		**Capacity (gpm)**	**TDH (ft)**
PS-3 (effluent from Palo Alto RWQCP to Palo Alto AWPF)	Near-Term	12,000	100’
PS-4 (effluent from Sunnyvale WPCP to Palo Alto AWPF)	Flexible Expansion	8,000	100’
PS-5 (purified water to LGRP)	Near-Term	6,950	360’
	Flexible Expansion	+9,750	400’
	Total	16,700	400’
Pipelines		**Diameter (in)**	**Length (ft)**
PL-5 (effluent from Palo Alto RWQCP to Palo Alto AWPF)	Near-Term	36”	15,150’
PL-6 (effluent from Sunnyvale WPCP to Palo Alto AWPF)	Flexible Expansion	36”	38,820’
PL-7 (purified water from Palo Alto AWPF to LGRP)	Near-Term	36”	107,400’
ROC management pipeline [b]	Near-Term	18”	10,900’
Palo Alto	Flexible Expansion	12”	13.900’
Mountain View – Whisman	Flexible Expansion	12”	5,300’
Sunnyvale – Mary	Flexible Expansion	12”	5,300’
Sunnyvale – Wolfe Evelyn	Flexible Expansion	12”	7,300’
Santa Clara, Jenny Strand Park/ VW, Treated Water Pipeline	Flexible Expansion	30”	11,200’
SJW – Campbell	Flexible Expansion	16”	1,600’
Delivery point improvements			
LGRP	Various infrastructure improvements (new pipes, monitoring equipment, etc.) required for LGRP to receive purified water (VW, 2018)		

a. *Potential future expansion requires hydraulic expansion and additional unit processes to produce up to 24 mgd treated to meet anticipated TWA water quality requirements.*

b. *ROC management design values are based on information reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD*

Table 3-6 contains estimated capital and annual O&M costs for TWA Flex, presented in 2019 dollars. Further cost details are included in Attachment B.

Table 3-6. Estimated Costs for Palo Alto TWA Flex

	Capital Cost [a] ($2019, in millions)			Annual O&M Cost [a] ($2019, in millions)		
Element	Near-Term Project (10 mgd) [b]	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)	Near-Term Project (10 mgd)	Flexible Expansion (+14 mgd) [c]	Total (24 mgd)
Palo Alto AWPF	$195	$195	$390	$6.0	$10.1	$16.1
Conveyance infrastructure	$290	$140	$430	$2.5	$2.7	$5.2
Effluent Pump Station (Palo Alto RWQCP to AWPF)						
Effluent Pipeline (Palo Alto RWQCP to AWPF)						
Effluent Pump Station (Sunnyvale WPCP to AWPF)						
Effluent Pipeline (Sunnyvale WPCP to AWPF)						
Purified Water Pump Station (AWPF to LGRP)						
Purified Water Pipeline (AWPF to LGRP)						
TWA Pipelines (AWPF to various TWA delivery points)						
LGRP improvements						
Pipeline easements						
Annual Potable Reuse Supply	--	--	--	$1.0	$1.4	$2.4
ROC Management (existing outfall) [d]	$35	--	$35	$0.7	$0.9	$1.6
Total	**$520**	**$335**	**$855**	**$10.2**	**$15.1**	**$25.3**

a. *All capital costs are rounded up to the nearest $5 million; annual O&M costs are rounded up to the nearest $100,000*

b. *The CoRe Plan includes an estimated capital cost of $200M for a 14 mgd Palo Alto AWPF (Portfolio 4). The capital cost shown here for a 10 mgd AWPF is similar due to: (i) rounding, in part, and (ii) inclusion of specific features, detailed in cost attachments, that would allow the near-term 10 mgd AWPF to accommodate future expansion.*

c. Expansion capital and O&M costs represent the incremental cost of modifications and construction to increase the 10 mgd facility by an additional 14 mgd.

d. *ROC management costs are based on the values reported in "Task 6 - Evaluation of ROC Management Options Final Report (9-1-20)" by GHD, de-escalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco.*

3.4 Flex Scenario Cost Comparison

Side-by-side graphical comparisons of near-term project and flex scenario capital and O&M costs are presented in Figures 3-8 and 3-9.

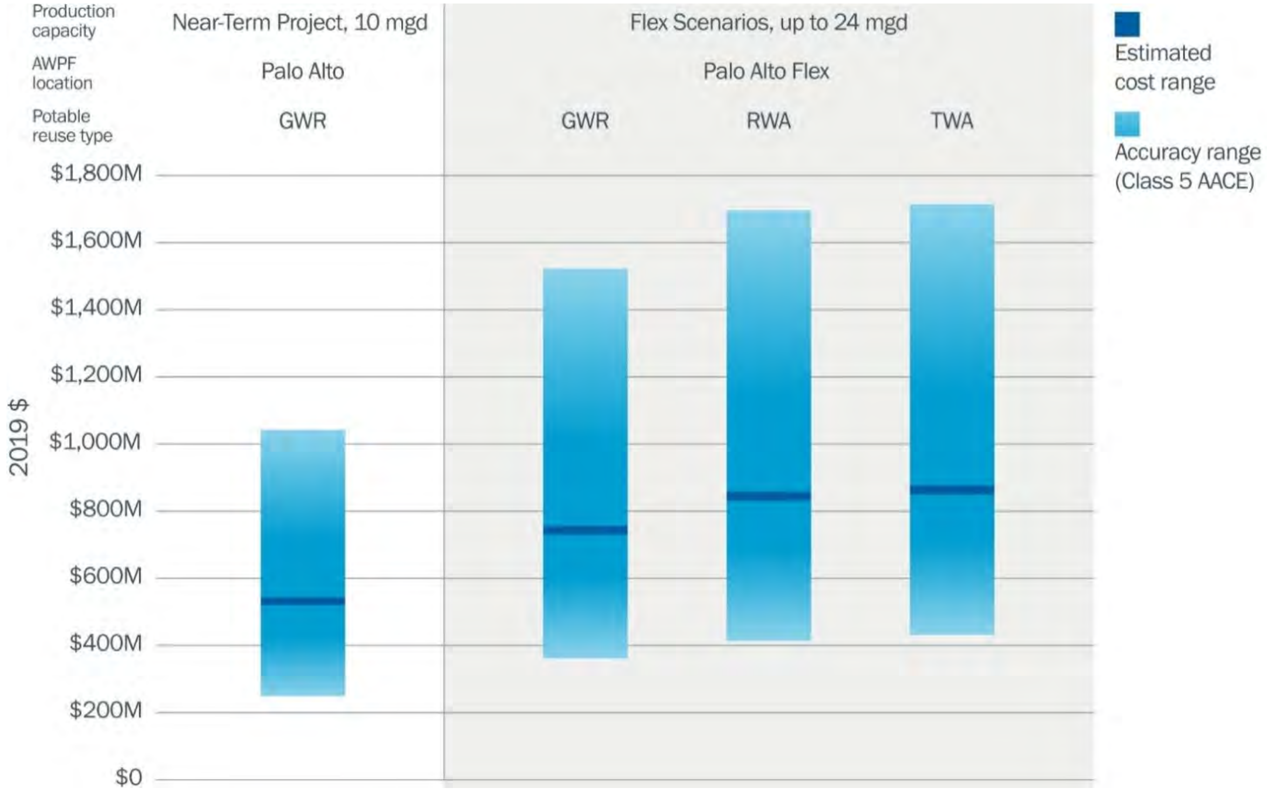

Figure 3-8. Estimated capital costs of Palo Alto flexible implementation scenarios

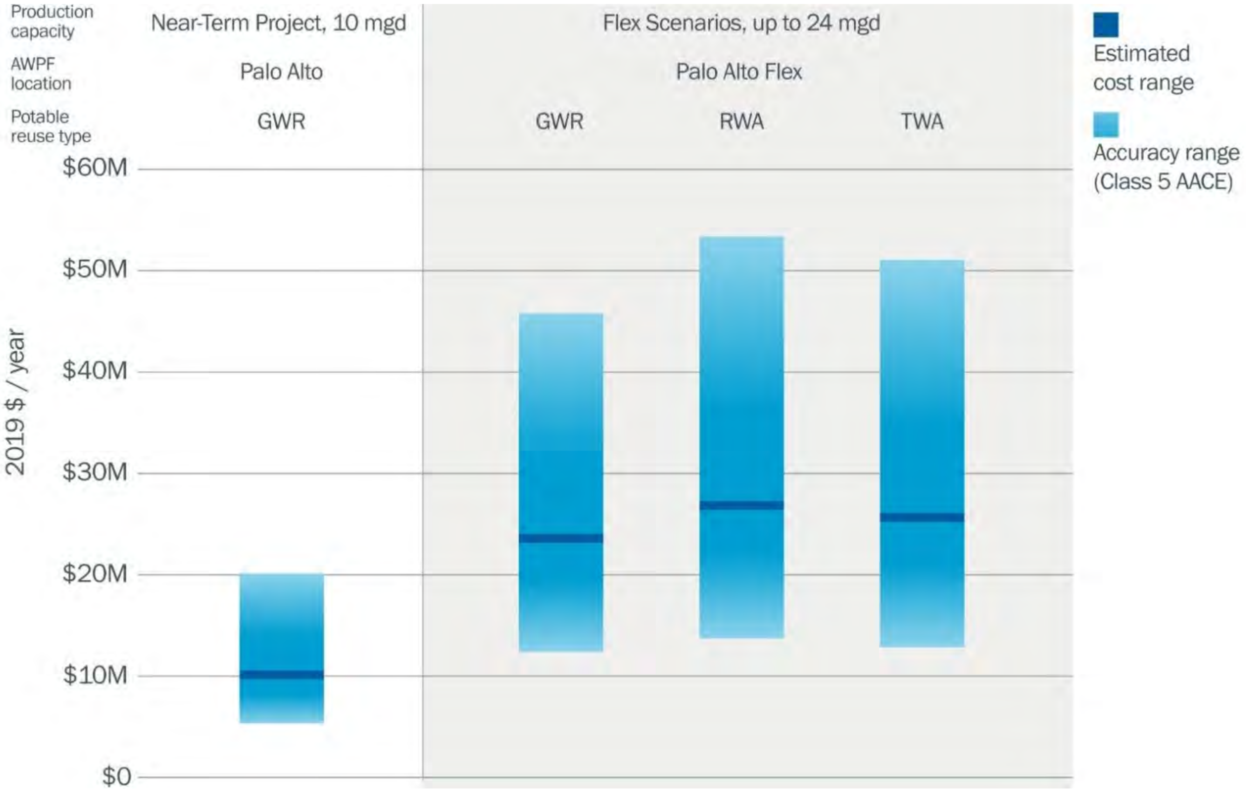

Figure 3-9. Estimated O&M costs of Palo Alto flexible implementation scenarios

Section 4: Pipeline Sizing Cost Evaluation

The project team conducted a high-level sensitivity evaluation to determine the cost impact of varying pipeline diameter for conveyance from the AWPF to LGRP. The evaluation uses Portfolio 2a (PA [+SV] GWR) costs as a basis and modifies conveyance sizing and costs based on an assumed diameter for the pipeline delivering purified water to LGRP. This evaluation does not include the costs of pipelines to deliver TWA via potable distribution systems or RWA via Rinconada WTP.

Five purified water pipeline sizes (diameters):

1. The first option is consistent with CoRe Plan Portfolio 2a (PA [+SV] GWR) and consists of a 48-inch pipeline capable of conveying up to 40 mgd[6] of purified water flow to LGRP.
2. The second option is consistent with scenarios in this Flex TM and consists of a 36-inch pipeline to LGRP capable of conveying up to 24 mgd of purified water.
3. The third option is a pipeline with tapering diameter that allows VW and its Partners to have up to 10 mgd of capacity available for GWR or RWA and up to 24 mgd of capacity available for TWA[7]. A tapered diameter pipeline could save capital cost while still delivering up to 24 mgd of purified water. As shown in Figure 4-1, the purified water pipeline has a 36-inch diameter before reducing to 24 inches following a large turnout at Santa Clara's Serra/Jenny Strand Park tanks. The large turnout is the potential TWA delivery point mentioned in Section 3 and Attachment A.
4. The fourth pipeline size evaluated uses a 30-inch pipeline to LGRP to deliver up to 16 mgd.
5. The fifth pipeline size evaluated uses a 24-inch pipeline to LGRP to deliver up to 10 mgd, which results in saving capital cost but limiting future opportunities to deliver additional purified water.

These pipeline options and turnouts require additional study to confirm engineering feasibility and are included to conceptually define order-of-magnitude cost savings of reducing pipeline diameters. Cost details of each option are shown in Attachment C.

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[6] Despite source flow limitations from Palo Alto RWQCP and Sunnyvale WPCP, sized for future expansion (up to 40 mgd) for comparability to Portfolio 1a (SJ GWR), which reflects SBWR Strategic Plan and the Purified Water Program Plan.

[7] Assuming an AWPF with 24 mgd capacity, delivering 10 mgd as GWR leaves up to 14 mgd available for TWA. Delivering 5 mgd as GWR may leave up to 5 mgd for RWA and up to 14 mgd for TWA. Foregoing GWR and RWA may leave up to 24 mgd for TWA, though seasonal flow patterns may limit deliveries.

Table 4-1. Estimated Conveyance Costs under Various Scenarios for Purified Water Pipeline Diameter from Palo Alto AWPF to LGRP

Purified Water Pipeline Diameter (in)	Conveyance Capacity for AWPF Buildout (mgd)		Conveyance Costs ($M)		Notes
	TWA	GWR or RWA	Capital	Annual O&M	
48”	Up to 40		$445	$5.1	Reflects CoRe Plan Portfolio 2a (PA [+SV] GWR) for 24 mgd. Despite source flow limitations from Palo Alto RWQCP and Sunnyvale WPCP, sized for future expansion (up to 40 mgd) for comparability to Portfolio 1a (SJ GWR), which reflects SBWR Strategic Plan and the Purified Water Program Plan.
36”	Up to 24		$375	$5.1	Reflects the flex implementation near-term project and potential future expansion for Palo Alto Flex.
Tapered/ graduated (36” to 24”)	Up to 24	Up to 10	$355	$5.2	Assumes up to 24 mgd of purified water, with 14 mgd for TWA and 10 mgd for GWR or RWA. Costs shown do not include pipelines to deliver TWA (via potable distribution) or RWA (via Rinconada WTP). Reduces diameter of the purified water pipeline from north to south (Figure 4-1); the diameter reduction from 36” to 24” occurs after Pruneridge Road (turnout to Santa Clara’s Serra/Jenny Strand Park tanks).
30”	Up to 16		$305	$3.6	Sized to deliver 16 mgd to any point along the purified water pipeline. Delivering more than 10 mgd requires a parallel pipeline and/or pump station.
24”	Up to 10		$215	$2.5	Sized to deliver 10 mgd to any point along the purified water pipeline. Delivering more than 10 mgd requires a parallel pipeline and/or pump station.

a. *Unless otherwise noted, general design criteria apply as follows: minimum pressure = 25 psi; pipe head loss <10 feet per 1,000 LF of pipe; pipe velocity <7 fps (generally 5-7 fps); Hazen-Williams coefficient (C) = 130, ductile iron pipe; efficiency = 65%; and safety factor = 10%. Design capacity of portfolio pump stations is included in Appendix A-5 along with cost assumptions for conveyance and other elements.*

b. *Attachment C includes cost breakdown of pipeline size options.*

c. *Assumes that pipeline easement cost is $32/foot.*

d. *Costs are rounded up to the nearest $5M for capital and $0.1M for O&M. Difference in annual O&M due to reduced pipeline diameter is expected to be minimal.*

Section 5: Considerations for Next Steps

VW’s Board has directed staff to proceed with the design and construction of a near-term potable reuse project for a 10 mgd AWPF to yield approximately 11,000 AFY using a public-private partnership (P3) delivery method. Flexible implementation scenarios offer a prudent planning approach to meeting the Board directive, while leaving a pathway to expand purified water use in the County in the future.

As stated in the introduction, flexible expansion intentionally plans for an array of possible outcomes and establishes a near-term project that preserves those future opportunities. Although implementation of flex scenarios is not certain, factors that may influence a future expansion include reliability of other water supplies; evolving regulatory requirements; changes in public acceptance; varying levels of political will; or shifts in magnitude, timing, and/or location of water demand.

Implementing a potable reuse project at Palo Alto is supported by the 2019 agreement between VW and Palo Alto committing a minimum average effluent volume of 9 mgd from Palo Alto’s RWQCP to VW at a cost of ~$100/AF to supply a regional AWPF. Next steps for implementation will be covered as part of the P3 project.

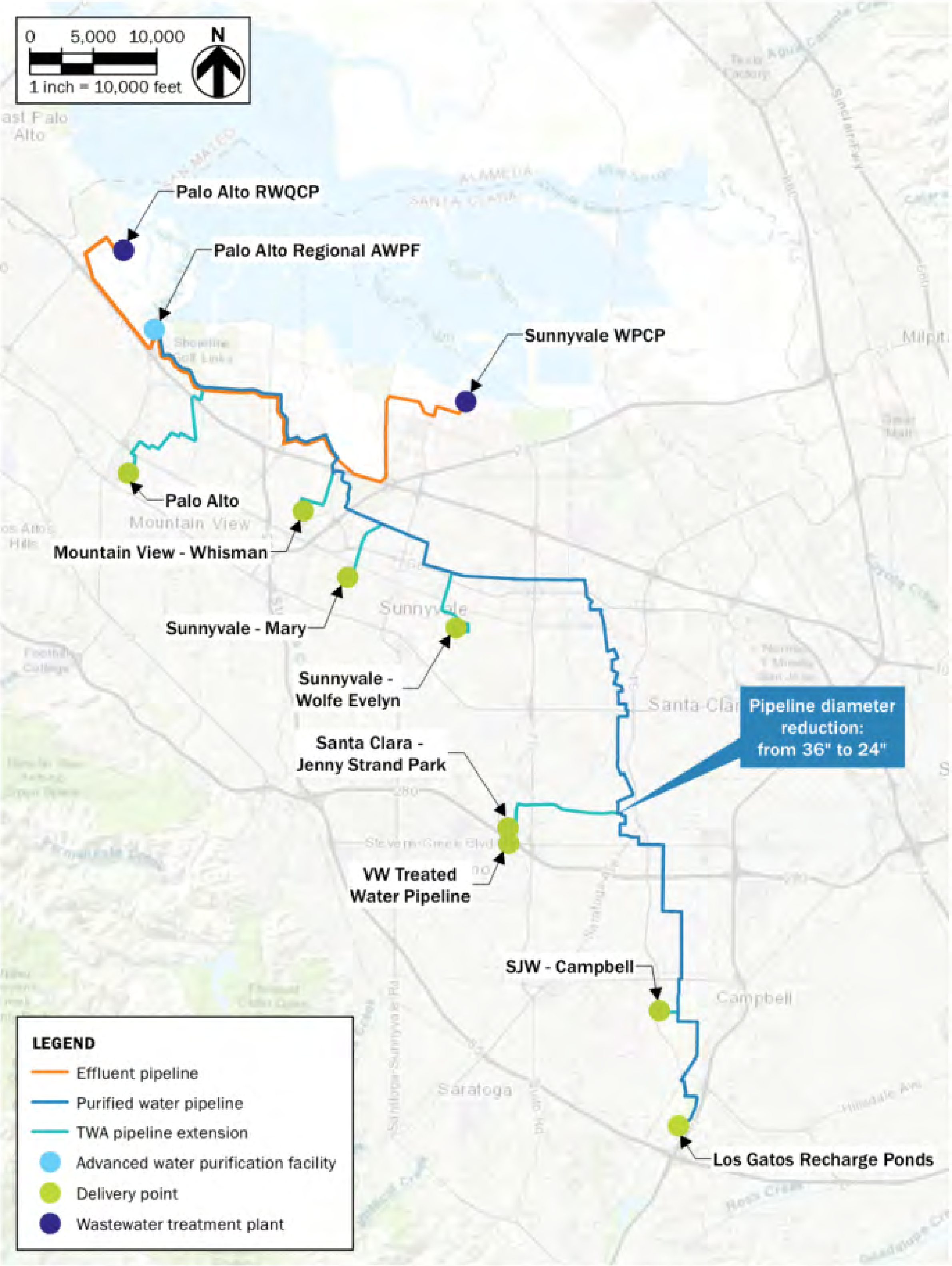

Figure 4-1. Facility locations, delivery points, and alignments for TWA Flex using pipelines tapered in diameter from the Palo Alto AWPF to LGRP

Attachment A: TWA Demand Assessment

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A.1 Treated Water Augmentation Demand Assessment

Estimated TWA demands along the GWR pipeline alignment were identified to assess potential future delivery points. Assumptions forming the basis of the TWA demand assessment follow.

- TWA deliveries are assumed to vary seasonally with lower demands during winter (rainy season) and higher demands during summer (dry season). Data on recent water use (2016-19) within retailers' service areas are used to estimate the average, minimum, and maximum TWA deliveries for normal years and to size infrastructure connecting the GWR pipeline and TWA delivery point.
- During higher water demands, purified water deliveries are assumed to be prioritized for TWA over GWR.
- During lower water demands, more purified water is assumed to be delivered to LGRP for GWR or to VW's treated water pipeline for TWA, rather than directly to retailers' TWA delivery points.
- During dry years, purified water deliveries for TWA are assumed to increase when other supplies are limited and estimated based on current understanding of each retailer's water supply situation.

The Palo Alto TWA scenario is based on the proposed Palo Alto GWR pipeline alignment, which crosses through the service areas for Palo Alto, Mountain View, Sunnyvale, Santa Clara, and SJW. Purified water for TWA could be delivered to each of these service areas from an expanded Palo Alto AWPF (with treatment processes added to the GWR treatment train, consistent with the CoRe Plan).

For preliminary planning purposes, delivery points are identified based on proximity of existing turnouts and major water infrastructure facilities to the GWR alignment. VW is considering these delivery points as a guide to conceptually plan the requirements to deliver purified water for TWA to each retailer and, as a next step, to estimate associated costs. Table A-1 presents the estimated delivery rates at each TWA delivery point along the Palo Alto GWR alignment. Maximum deliveries reflect the assumed capacity of the lateral pipeline that would connect the GWR pipeline to the respective delivery point. To confirm the capacity to receive purified water for TWA, subsequent work would be required to hydraulically model the retailer's service area.

Table A-1. Potential TWA Deliveries along the Palo Alto GWR Alignment

		Potential TWA and GWR Deliveries (mgd)					
		Normal Year			Dry Year		
Delivery Point	Reuse Type	Min	Avg	Max	Min	Avg	Max
VW – LGRP system	GWR	2	8	10	3	4	10
SJW - Campbell	TWA	1.5	2	2.5	1.5	2	2.5
Palo Alto – Treated Water System	TWA	0	0	0	0.5	1	1.5
Mountain View – Whisman	TWA	0.5	1	1.5	1	2	2.5
Sunnyvale – Mary	TWA	0	0	0	0.5	1	1.5
Sunnyvale – Wolfe Evelyn	TWA	0	0	0	0.5	1	1.5
Santa Clara – Jenny Strand Park	TWA	2.5	4.5	6	3	5.5	6.5
VW – Treated Water Lateral	TWA	2	8.5	10	5	7.5	8
Total		24			24		

A.2 City of Palo Alto

Palo Alto's augments its primary potable water supply, SFPUC wholesale supply, with local groundwater and does not currently receive treated water from VW. TWA deliveries to Palo Alto would not change the reliability of VW deliveries within the County.

Palo Alto's existing potable supply is ample during normal years; thus, TWA deliveries are not estimated in normal conditions. However, in future severe droughts, existing supply sources may be limited, and the City may benefit from a drought-resistant local supply, such as TWA.

Purified water for TWA could be delivered to Palo Alto near existing SFPUC turnouts. For preliminary planning purposes, the delivery point is assumed to be located east of San Antonio Road, between Central and El Camino Expressway near a larger diameter Palo Alto pipeline. It was assumed that Palo Alto would receive on average 1 mgd of TWA deliveries during dry years, peaking to 1.5 mgd during summer months. This supply would be directly delivered to portions of the Palo Alto's treated water distribution system at pressure.

A.3 City of Mountain View

Mountain View's potable supply sources include purchases from SFPUC (primary source of supply serving most of the city's service area) and VW, as well as groundwater. CalWater provides water to scattered parcels within portions of the service area supplied by SFPUC and VW.

Mountain View has a reliable water supply during normal years. Thus, for the purpose of preliminary planning, TWA deliveries are estimated at 1 mgd during normal years, which is approximately 50% of the existing VW deliveries to Mountain View. However, the TWA delivery point would be located at or near the Whisman Reservoir, an area served by SFPUC supply. The quantity of purified water supply is assumed to increase in dry years to augment supply due to reduced availability of existing sources.

A.4 City of Sunnyvale

Significant portions of Sunnyvale's water distribution system are supplied by SFPUC and VW purchases, as well as local groundwater. Overall, Sunnyvale has ample water supply during normal years.

In dry years, reduced availability of existing supplies could lead to the need for drought-resistant local supply, such as TWA deliveries. The Palo Alto GWR PL alignment traverses near two water storage tanks (referred to as plants) in Sunnyvale—the Mary and Wolfe Evelyn Water Plants (Tanks). It is assumed that purified water would be blended with treated water in each of the two tanks at an average rate of 1 mgd each during dry years, increasing to 1.5 mgd during peak months.

A.5 City of Santa Clara

Because Highway 101 separates the Palo Alto GWR pipeline alignment from Santa Clara's Northside Tanks, Santa Clara TWA deliveries would occur at the Jenny Strand Park turnout (not the tanks). To achieve the same overall purified water supply to Santa Clara, TWA deliveries to the Jenny Strand Park turnout increase by 1 mgd (minimum, average, and maximum) compared to those considered under San José flex scenarios.

In addition to serving local demands, TWA deliveries could be routed to VW turnouts through the existing treated water lateral. To do this, the proposed purified water pipeline would be connected directly into the VW treated water pipeline. Flow into the purified water pipeline would be reversed, and VW could deliver purified water to other turnouts within their treated water distribution system. It was assumed that an average of 8.5 mgd would be conveyed in this manner, peaking to 10 mgd during peak month conditions.

A.6 San Jose Water

TWA deliveries to SJW are assumed to be the same for the Palo Alto GWR and San José GWR alignments.

Attachment B: Palo Alto Flex Scenario Cost Estimates

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Table B-1. Overview of Capital and Annual O&M Costs for Palo Alto Flex Scenarios

									Purified water yield (AFY)		Near-term project (10 mgd) costs ($M)				Expansion (+14 mgd) costs ($M)				Buildout (24 mgd) total costs ($M)	
Table no. in CoRe Plan Appendix A-6	**Table no. in Palo Alto Flex TM Attachment B**	**ID no.**	**Project element**	**Location or start point**	**End point**	**Diameter (in)**	**Length (LF)**	**Length (miles)**	**Lower bound**	**Upper bound [a]**	**Capital**	**Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**	**Capital**	**Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**	**Rounded Capital**	**Rounded Annual O&M**
Palo Alto GWR Flex Scenario																				
–	Table B-2	AWPF	AWPF - GWR Flex	Palo Alto	–	–	–	–	–	–	$ 191	$ 5.8	$ 195	$ 5.9	$ 141	$ 7.5	$ 145	$ 7.5	$ 340	$ 13.4
Table 23	–	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	15,150	2.9	–	–	$ 29	$ 0.03	$ 290	$ 2.5	$ -	$ -	$ 95	$ 2.6	$ 385	$ 5.1
Table 24	–	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	38,820	7.4	–	–	$ -	$ -			$ 75	$ 0.1				
–	Table B-5	PL-7-Alt	Purified Water Pipeline	Palo Alto AWPF	LGRP	36	107,400	20.3	–	–	$ 213	$ 0.2			$ -	$ -				
Table 26	–	PS-3	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	–	–	–	–	–	$ 4	$ 0.6			$ -	$ -				
Table 27	–	PS-4	Pump Station	Sunnyvale WPCP	Palo Alto AWPF	–	–	–	–	–	$ -	$ -			$ 4	$ 0.4				
–	Table B-13/14	PS-5	Pump Station	Palo Alto AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.3			$ 13	$ 2.1				
Table 29	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	161,370	30.6	–	–	$ 4	$ -			$ 1	$ -				
–	–	Source water	Purchased supply for reuse[b]	PA RWQCP and SV WPCP	–	–	–	–	17,000	23,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.3	$ -	$ 1.4	$ -	$ 2.4
–	–	ROCM-2a	ROCM strategy	–	–	–	–	–	–	–	$ 34	$ 0.6	$ 35	$ 0.7	$ -	$ 0.9	$ -	$ 0.9	$ 35	$ 1.6
TOTAL - Excluding ROCM													$ 485	$ 9.4			$ 240	$ 11.5	$ 725	$ 20.9
TOTAL													**$ 520**	**$ 10.1**			**$ 240**	**$ 12.4**	**$ 760**	**$ 22.5**
Palo Alto RWA Flex Scenario																				
–	Table B-3	AWPF	AWPF - RWA Flex	Palo Alto	–	–	–	–	–	–	$ 191	$ 5.8	$ 195	$ 5.9	$ 187	$ 9.7	$ 190	$ 9.8	$ 385	$ 15.7
Table 23	–	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	15,150	2.9	–	–	$ 29	$ 0.03	$ 290	$ 2.5	$ -	$ -	$ 140	$ 4.6	$ 430	$ 7.1
Table 24	–	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	38,820	7.4	–	–	$ -	$ -			$ 75	$ 0.1				
–	Table B-5	PL-7-Alt	Purified Water Pipeline	Palo Alto AWPF	LGRP	36	107,400	20.3	–	–	$ 213	$ 0.2			$ -	$ -				
–	Table B-6	Rinconada Extension PL	Purified Water Pipeline	LGRP	Rinconada WTP	36	12,400	2.3	–	–	$ -	$ -			$ 24	$ 0.02				
Table 26	–	PS-3	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	–	–	–	–	–	$ 4	$ 0.6			$ -	$ -				
Table 27	–	PS-4	Pump Station	Sunnyvale WPCP	Palo Alto AWPF	–	–	–	–	–	$ -	$ -			$ 4	$ 0.4				
–	Table B-13/14	PS-5	Pump Station	Palo Alto AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.3			$ 13	$ 2.1				
–	Table B-15	Rinconada RWA Booster PS	Pump Station	LGRP	Rinconada WTP	–	–	–	–	–	$ -	$ -			$ 18	$ 2.0				
Table 29	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	161,370	32.9	–	–	$ 4	$ -			$ 2	$ -				
–	–	Source water	Purchased supply for reuse[b]	PA RWQCP and SV WPCP	–	–	–	–	17,000	23,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.3	$ -	$ 1.4	$ -	$ 2.4
–	–	ROCM-2a	ROCM strategy	–	–	–	–	–	–	–	$ 34	$ 0.6	$ 35	$ 0.7	$ -	$ 0.9	$ -	$ 0.9	$ 35	$ 1.6
TOTAL - Excluding ROCM													$ 485	$ 9.4			$ 330	$ 15.8	$ 815	$ 25.2
TOTAL													**$ 520**	**$ 10.1**			**$ 330**	**$ 16.7**	**$ 850**	**$ 26.8**
Palo Alto TWA Flex Scenario																				
–	Table B-4	AWPF	AWPF - TWA Flex	Palo Alto	–	–	–	–	–	–	$ 195	$ 6.0	$ 195	$ 6.0	$ 194	$ 10.1	$ 195	$ 10.1	$ 390	$ 16.1
Table 23	–	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	15,150	2.9	–	–	$ 29	$ 0.03	$ 290	$ 2.5	$ -	$ -	$ 140	$ 2.7	$ 430	$ 5.2
Table 24	–	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	38,820	7.4	–	–	$ -	$ -			$ 75	$ 0.1				
–	Table B-5	PL-7-Alt	Purified Water Pipeline	Palo Alto AWPF	LGRP	36	107,400	20.3	–	–	$ 213	$ 0.2			$ -	$ -				
–	Table B-7	DP-5	Purified Water Pipeline	PL-2-Alt Junction	SJW - Campbell	16	1,600	0.3	–	–	$ -	$ -			$ 1	$ 0.0				
–	Table B-8	DP-6 PL	Purified Water Pipeline	PL-2-Alt Junction	Palo Alto	12	13,900	2.6	–	–	$ -	$ -			$ 9	$ 0.0				
–	Table B-9	DP-7 PL	Purified Water Pipeline	PL-2-Alt Junction	Mountain View - Whisman	12	5,300	1.0	–	–	$ -	$ -			$ 4	$ 0.0				
–	Table B-10	DP-8 PL	Purified Water Pipeline	PL-2-Alt Junction	Sunnyvale - Mary	12	5,300	1.0	–	–	$ -	$ -			$ 4	$ 0.0				
–	Table B-11	DP-9 PL	Purified Water Pipeline	PL-2-Alt Junction	Sunnyvale - Wolfe Evelyn/ Central	12	7,300	1.4	–	–	$ -	$ -			$ 5	$ 0.0				
–	Table B-12	DP-10/11 PL	Purified Water Pipeline	PL-2-Alt Junction	Santa Clara - Jenny Strand Park/VW Treated Water PL	30	11,200	2.1	–	–	$ -	$ -			$ 19	$ 0.0				
Table 26	–	PS-3	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	–	–	–	–	–	$ 4	$ 0.6			$ -	$ -				
Table 27	–	PS-4	Pump Station	Sunnyvale WPCP	Palo Alto AWPF	–	–	–	–	–	$ -	$ -			$ 4	$ 0.4				
–	Table B-13/14	PS-5	Pump Station	Palo Alto AWPF	LGRP	–	–	–	–	–	$ 20	$ 1.3			$ 13	$ 2.1				
Table 29	–	LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	–	$ 15	$ 0.4			$ -	$ -				
–	–	PL Easements	Easement[c]	–	–	–	205,970	39.0	–	–	$ 4	$ -			$ 3	$ -				
–	–	Source water	Purchased supply for reuse[b]	PA RWQCP and SV WPCP	–	–	–	–	17,000	23,000	$ -	$ 1.0	$ -	$ 1.0	$ -	$ 1.3	$ -	$ 1.4	$ -	$ 2.4
–	–	ROCM-2a	ROCM strategy	–	–	–	–	–	–	–	$ 34	$ 0.6	$ 35	$ 0.7	$ -	$ 0.9	$ -	$ 0.9	$ 35	$ 1.6
TOTAL - Excluding ROCM													$ 485	$ 9.5			$ 335	$ 14.2	$ 820	$ 23.7
TOTAL													**$ 520**	**$ 10.2**			**$ 335**	**$ 15.1**	**$ 855**	**$ 25.3**

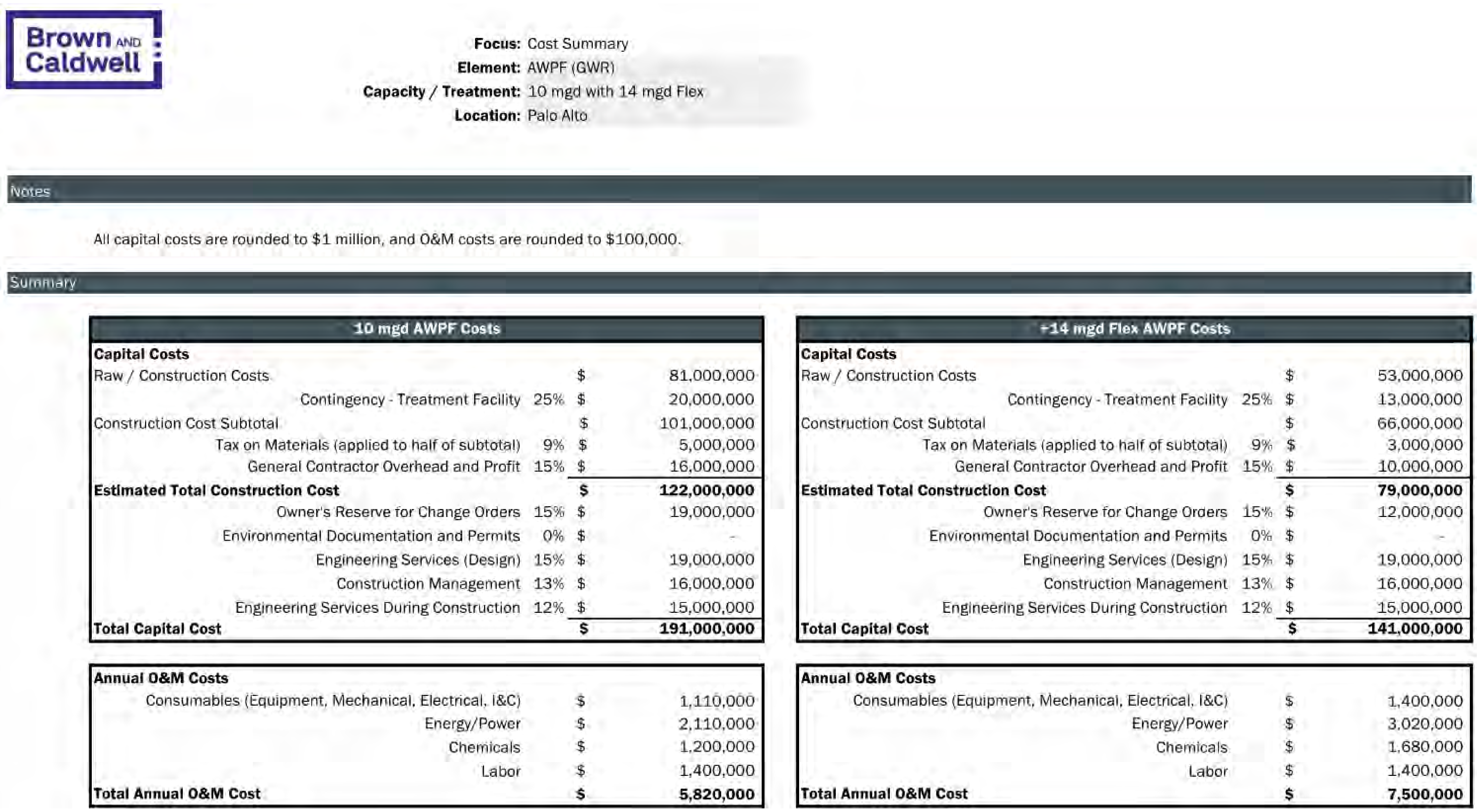
a. Upper bound of yield is assumed in facility sizing for cost estimates and for the purposes of calculating source water costs. Lower bound reflects potential source water availability limitations or delivery point limitations (e.g., groundwater basin capacity). See Appendix A-2 for additional information on flow assumptions.

b. Assumes unit cost of source water purchased as supply for all scenarios is $100/AF.

c. Assumes that pipeline easement cost is $32/foot for all pipelines.

d. All costs reported in July 2019 dollars.

Table B-2. Cost Estimate Details: Palo Alto AWPF for GWR Flex



Focus: Cost Summary
Element: AWPF (GWR)
Capacity / Treatment: 10 mgd with 14 mgd Flex
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	81,000,000
Contingency - Treatment Facility	25%	$	20,000,000
Construction Cost Subtotal		$	101,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**122,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	16,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**191,000,000**

+14 mgd Flex AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	53,000,000
Contingency - Treatment Facility	25%	$	13,000,000
Construction Cost Subtotal		$	66,000,000
Tax on Materials (applied to half of subtotal)	9%	$	3,000,000
General Contractor Overhead and Profit	15%	$	10,000,000
Estimated Total Construction Cost		**$**	**79,000,000**
Owner's Reserve for Change Orders	15%	$	12,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	16,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**141,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,110,000
Energy/Power	$	2,110,000
Chemicals	$	1,200,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**5,820,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,400,000
Energy/Power	$	3,020,000
Chemicals	$	1,680,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**7,500,000**

10 mgd AWPF Costs		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,378,900	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 7,131,400	9%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,393,500	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,573,800	12%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 4,040,800	5%
Division 32 – Exterior Improvements	$ 111,200	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,709,900	11%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 15,852,400	20%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,245,900	31%
TOTAL	**$ 81,000,000**	

14 mgd Flex AWPF Costs		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 4,811,720	6%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ -	0%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 437,500	1%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 1,948,410	2%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 7,793,642	10%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,962,688	11%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 2,412,820	3%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,978,806	32%
TOTAL	**$ 53,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **10 mgd with 14 mgd Flex**
Location: **Palo Alto**

Date: 12/4/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C Assumptions	Cost	Notes	Additional costs	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 73,788,100	10% of Divisions 2-47	$ 7,378,900		$ 4,811,720	10% of Divisions 2-47
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500		$ -	
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800		$ -	
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400		$ -	
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	Used Means est for structural backfill, but seems low.	$ -	
Division 31 – Earthwork	Sitework	Excavation		37,566	CY		$ 11.78			$ 442,600		$ -	
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000		$ -	
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200		$ -	
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300		$ -	
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500		$ -	
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700		$ -	
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500		$ -	
Division 31 – Earthwork	Sitework	Gravel		12,781	SY		$ 4.63			$ 59,200		$ -	
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000		$ -	
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500		$ -	
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200		$	
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000		$ -	
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000		$ -	
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values-14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank	$ -	
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.	$ -	
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure	$ -	
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure	$ -	
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin	$ -	
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin	$ -	
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin	$ -	
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment	$ -	
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage	$ -	
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage	$ -	
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building	$ -	
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical	$ -	
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical	$ -	
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station	$ -	
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station	$ -	
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200		$ -	
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 312,500	Engineer's Estimate	$ 312,500	for 24 MGD facility	$ 437,500	
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 416,667	Engineer's Estimate	$ 416,700	for 24 MGD facility	$ 583,333	
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	ea	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **10 mgd with 14 mgd Flex**
Location: **Palo Alto**

Date: 12/4/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method D: Assumptions	Cost	Notes	Additional costs	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainors, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Scaled down from the 10.5 MGD facility	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank: $7 per gal including appurtenances	$ 84,000		$ -	
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,766				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,042,900	Scaled down from the 10.5 MGD facility	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,384				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment		Fan System							Decarbonator components	$ -		$ -	
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			1 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP, scaled costs down from 24 mgd AWPF based on assumption of only needing two (2) 12 mgd (1 duty and 1 standby) reactors.	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing	$ -	
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements	$ -	
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building	$ -	
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	0.5	EA	$ 3,650,000			Scaled back from DN Tanks cost proposal for 4 MG tank, need one 2 MG tank for 10 mgd	$ 1,825,000	Prestressed Concrete Tank	$ 1,825,000	Need an additional 2 MG tank for 14 mgd
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)	$ -	
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF (GWR)**
Capacity:	**10 mgd with 14 mgd Flex**
Location:	**Palo Alto**

Date:	12/4/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Estimate Date:	R. Guillen
Checked By:	D. Mulacek

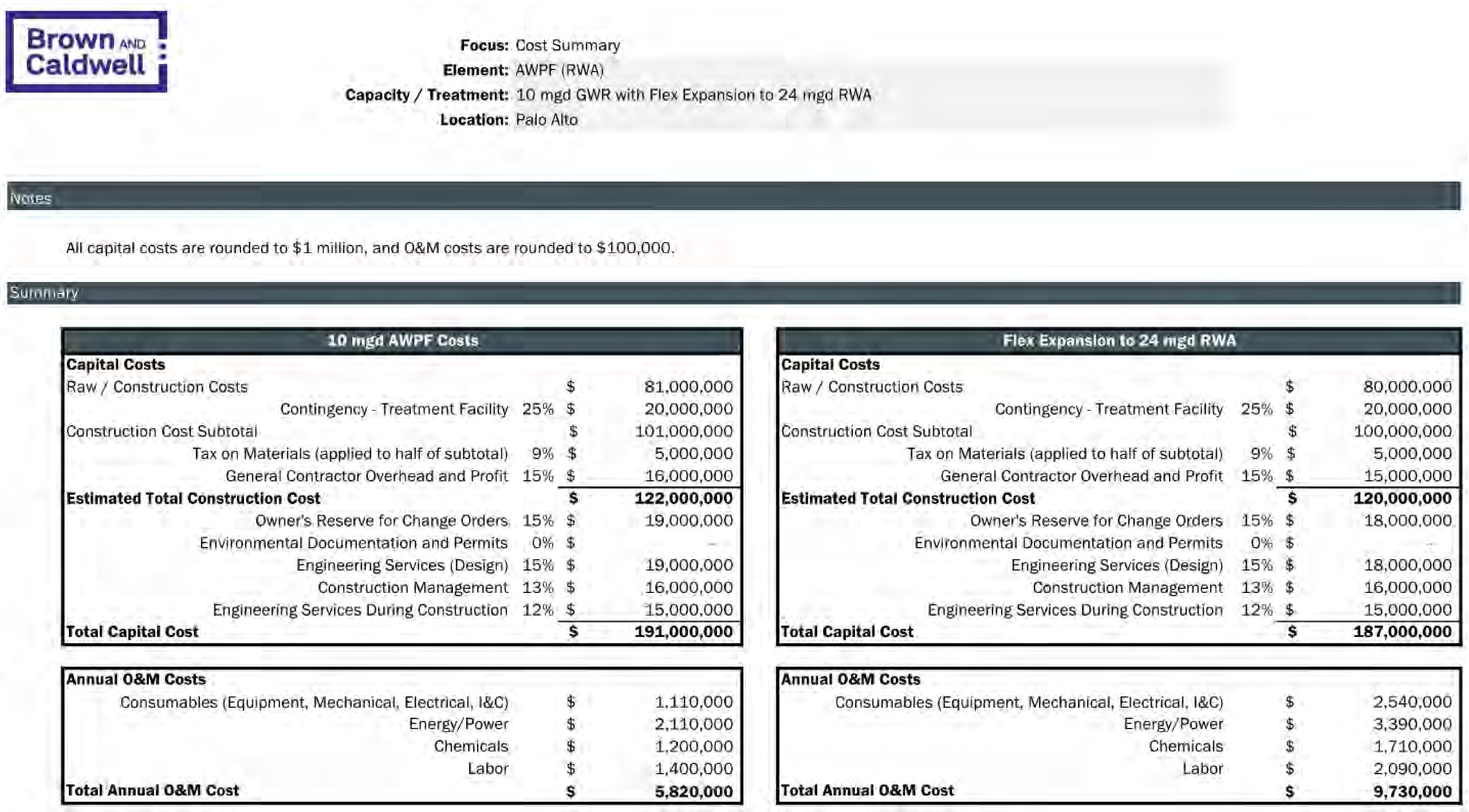
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C, Assumptions	Cost	Notes	Additional costs	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 7,793,642	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 389,682	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 389,682	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 389,682	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 7,793,642	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 9,573,800	25% of Electrical Costs	$ 2,393,500		$ 1,948,410	25% of Electrical Costs
O&M	Consumables	UF Membranes Replacement		338	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	RO Membranes Replacement		385	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 133,700	installation costs must be covered by O&M labor	$ 187,101	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	installation costs must be covered by O&M labor	$ 48,067	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor	$ 26,679	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 946,900	2% of Pumping Equipment Cost	$ 19,000		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,573,800	2% of Electrical Cost	$ 191,500		$ 155,873	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,393,500	2% of Instrumentation & Controls Cost	$ 47,900		$ 38,968	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 500		$ 619	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 600		$ 809	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Feed Pumps		12,253,050	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 1,267,700		$ 1,774,659	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Inter-Stage Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 200		$ 143	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 22,600		$ 31,549	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 56,400		$ 78,874	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (GWR)**
Capacity: **10 mgd with 14 mgd Flex**
Location: **Palo Alto**

Date: 12/4/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Gullien
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method D: Assumptions	Cost	Notes	Additional costs	Notes
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 188,900		$ 264,322	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		490,122	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 50,800		$ 106,480	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Waste Equalization Pumps		81,687	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 8,500		$ 47,324	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 2,000		$ 2,761	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 48,400		$ 67,713	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 1,300		$ 1,761	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 8,400		$ 11,897	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 128,500		$ 179,812	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 115,400		$ 161,444	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 537,400		$ 752,236	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Lime		365,511	lb		$ 0.15		based on 12 mg/L dose	$ 54,800		$ 76,684	based on 12 mg/L dose
O&M	Chemicals	Sulfuric Acid		11,200	gal		$ 1.00		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 11,200		$ 15,650	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Antiscalant		11,000	gal		$ 20.56		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 226,300		$ 316,688	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO Low pH Cleaner		8,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 47,400		$ 66,283	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	RO High pH Cleaner		8,500	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 24,600		$ 34,307	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Labor	Water Plant Operator		2,080	hours/yr		$ 163.20			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)	$ 679,000	Assumes two additional plant operators 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Sr Mechanics		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Control Tech II		2,080	hours/yr		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2,080	hours/yr		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)	$ -	

Table B-3. Cost Estimate Details: Palo Alto AWPF for RWA Flex



Focus: Cost Summary
Element: AWPF (RWA)
Capacity / Treatment: 10 mgd GWR with Flex Expansion to 24 mgd RWA
Location: Palo Alto

Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	81,000,000
Contingency - Treatment Facility	25%	$	20,000,000
Construction Cost Subtotal		$	101,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**122,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	16,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**191,000,000**

Flex Expansion to 24 mgd RWA			
Capital Costs			
Raw / Construction Costs		$	80,000,000
Contingency - Treatment Facility	25%	$	20,000,000
Construction Cost Subtotal		$	100,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	15,000,000
Estimated Total Construction Cost		**$**	**120,000,000**
Owner's Reserve for Change Orders	15%	$	18,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	18,000,000
Construction Management	13%	$	16,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**187,000,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	1,110,000
Energy/Power	$	2,110,000
Chemicals	$	1,200,000
Labor	$	1,400,000
Total Annual O&M Cost	**$**	**5,820,000**

Annual O&M Costs		
Consumables (Equipment, Mechanical, Electrical, I&C)	$	2,540,000
Energy/Power	$	3,390,000
Chemicals	$	1,710,000
Labor	$	2,090,000
Total Annual O&M Cost	**$**	**9,730,000**

10 mgd AWPF Costs		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,377,500	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 7,131,400	9%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,393,500	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,573,800	12%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 4,027,300	5%
Division 32 – Exterior Improvements	$ 111,200	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,709,900	11%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 15,852,400	20%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,245,900	31%
TOTAL	**$ 81,000,000**	

Flex Expansion to 24 mgd RWA		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,242,987	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 1,612,800	2%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	**$ 437,500**	1%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,938,230	4%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 11,752,922	15%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 13,515,860	17%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 2,412,820	3%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 39,176,406	49%
TOTAL	**$ 80,000,000**	

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 10 mgd GWR with Flex Expansion to 24 mgd RWA
Location: Palo Alto

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 73,774,600	10% of Divisions 2-47	$ 7,377,500		$ 7,242,987	10% of Divisions 2-47
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500			
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800			
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400			
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here		
Division 31 – Earthwork	Sitework	Excavation		37,086	CY		$ 11.78			$ 436,900			
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000			
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200			
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300			
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500			
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700			
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500			
Division 31 – Earthwork	Sitework	Gravel		11,101	SY		$ 4.63			$ 51,400			
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000			
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500			
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200			
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000			
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$2,000,000	Engineers estimate	$ 2,000,000			
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank		
Division 31 – Earthwork	Sitework	Potholing		0	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ -	plant infrastructure		
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.		
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure		
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure		
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin		
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin		
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin		
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 119,500	Added as part of TWA expansion
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 56,800	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 206,400	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 627,900	Added as part of TWA expansion
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ -	BAC	$ 275,200	Added as part of TWA expansion
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ -	BAC	$ 327,000	Added as part of TWA expansion
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment		
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment		
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage		
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage		
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building		
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical		
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station		
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200			
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 312,500	Engineer's Estimate	$ 312,500	Scaled down from the 24 MGD facility	$ 437,500	Scaled down from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 416,667	Engineer's Estimate	$ 416,700	Scaled down from the 24 MGD facility	$ 583,333	Scaled down from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ -		$ 7,455,900	Added as part of TWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ -		$ 5,741,700	Added as part of TWA expansion

Brown AND Caldwell

Focus: Cost Inputs and R&R
Aspect: AWPF (RWA)
Capacity: 10 mgd GWR with Flex Expansion to 24 mgd RWA
Location: Palo Alto

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	ea	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Filtration Treatment	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000			
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,786				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, control panel, and startup	$ 13,042,900	Filtration Treatment	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			2 duty; 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System		
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	2	0.5	EA	$ 3,650,000			Scaled back from DN Tanks cost proposal for 4 MG tank, need one 2 MG tank for 10 mgd	$ 1,825,000	Prestressed Concrete Tanks	$ 1,825,000	Need an additional 2 MG tank for 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.

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Estimate Date: R. Guillen
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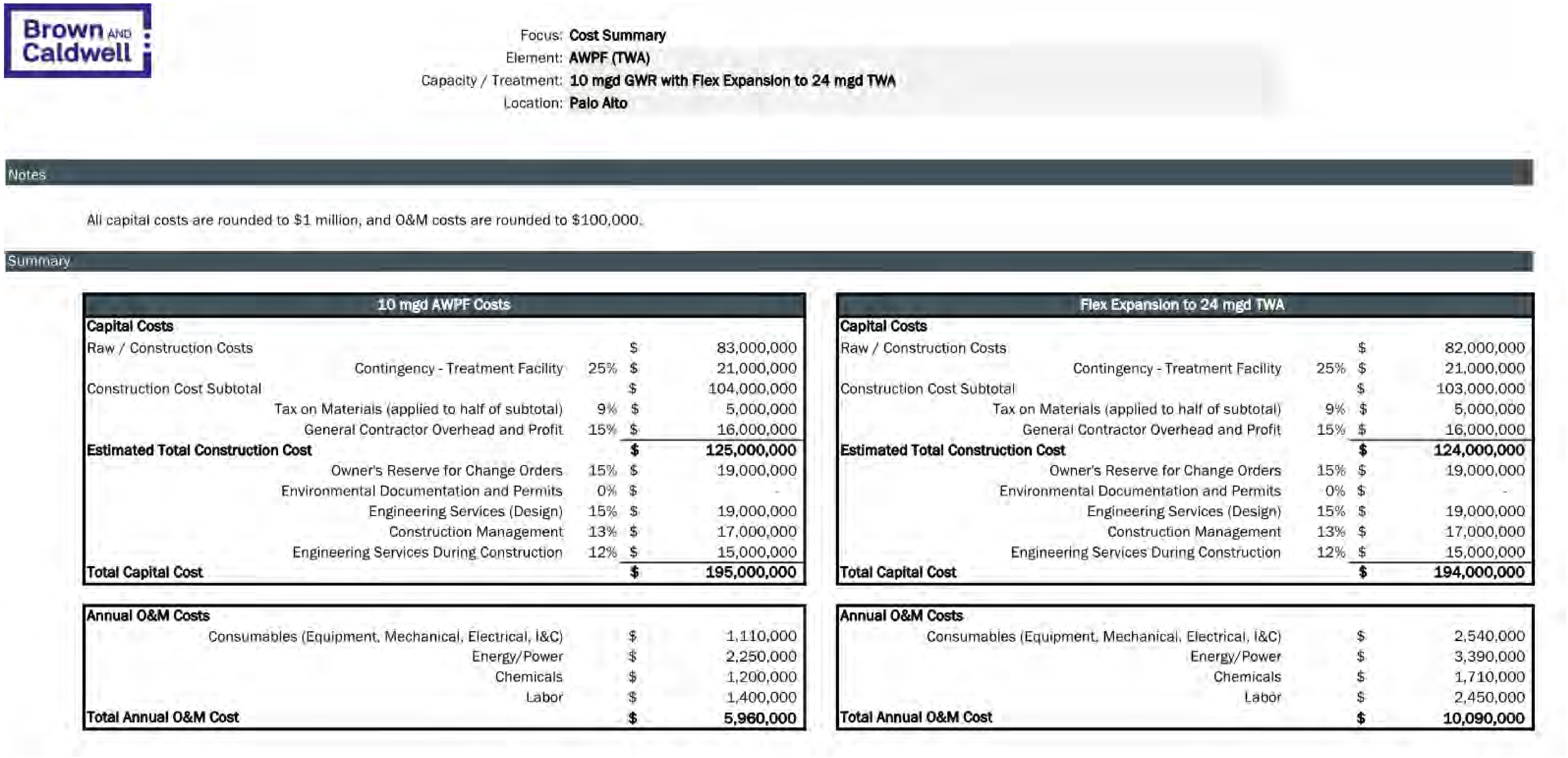
						Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz, Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 11,752,922	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 11,752,922	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 9,573,800	25% of Electrical Costs	$ 2,393,500		$ 2,938,230	25% of Electrical Costs
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ -		$ 1,046,200	Added as part of TWA expansion
O&M	Consumables	UF Membranes Replacement		338	membranes per year		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Consumables	RO Membranes Replacement		385	membranes per year		$ 347		Based on a typical membrane life of 5 years	$ 133,700	installation costs must be covered by O&M labor	$ 187,101	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	lamps per year		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	installation costs must be covered by O&M labor	$ 48,067	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Consumables	UV Ballast Replacement		24	ballast per year		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor	$ 26,679	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 946,900	2% of Pumping Equipment Cost	$ 19,000		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,573,800	2% of Electrical Cost	$ 191,500		$ 235,058	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,393,500	2% of Instrumentation & Controls Cost	$ 47,900		$ 58,765	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Original costs for 24 mgd AWPF scaled down for 10 mgd AWPF	$ 225,400		$ 315,495	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ -		$ 290,800	Added as part of TWA expansion
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ -		$ 14,900	Added as part of TWA expansion
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ -		$ 21,800	Added as part of TWA expansion
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ -		$ 30,500	Added as part of TWA expansion
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ -		$ 11,900	Added as part of TWA expansion
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ -		$ 4,000	Added as part of TWA expansion
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 500		$ 619	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 600		$ 809	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 225,400		$ 315,495	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	RO Inter-Stage Pumps		272,290	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 28,200		$ 39,437	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 200		$ 143	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 28,200		$ 39,437	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 22,600		$ 31,549	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 56,400		$ 78,874	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 188,900		$ 264,322	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		490,122	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 50,800		$ 106,480	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	Waste Equalization Pumps		81,687	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 8,500		$ 47,324	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 2,000		$ 2,761	Original costs for 24 mgd AWPF scaled down for 14 mgd AWPF
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ -		$ 21,100	Added as part of TWA expansion
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 48,400		$ 67,713	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 1,300		$ 1,761	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 8,400		$ 11,697	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 128,500		$ 179,812	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 115,400		$ 161,444	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 537,400		$ 752,236	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	Lime		365,511	lb		$ 0.15		based on 12 mg/L dose	$ 54,800		$ 76,684	based on 12 mg/L dose
O&M	Chemicals	Sulfuric Acid		11,200	gal		$ 1.00		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 11,200		$ 15,650	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	RO Antiscalant		11,000	gal		$ 20.56		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 226,300		$ 316,688	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	RO Low pH Cleaner		8,500	gal		$ 5.57		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 47,400		$ 66,283	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Chemicals	RO High pH Cleaner		8,500	gal		$ 2.88		Original costs for 24 mgd; scaled down for 10 mgd AWPF	$ 24,600		$ 34,307	Original costs for 24 mgd; scaled down for 14 mgd AWPF
O&M	Labor	Water Plant Operator		2,080	hours per year		$ 163.20			$ 339,500	Assumes one plant operator 40 hours per week for 52 weeks in a year (1 FTE)	$ 1,018,500	Assumes3 additional plant operators 40 hours per week for 52 weeks in a year (3 FTEs)
O&M	Labor	Sr Mechanics		2,080	hours per year		$ 172.27			$ 358,400	Assumes one senior mechanic 40 hours per week for 52 weeks in a year (1 FTE)	$ 716,800	Assumes two additional senior mechanic 40 hours per week for 52 weeks in a year (2 FTE)
O&M	Labor	Control Tech II		2,080	hours per year		$ 172.27			$ 358,400	Assumes one control tech 40 hours per week for 52 weeks in a year (1 FTE)	$ 358,400	Assumes one additional control tech 40 hours per week for 52 weeks in a year (1 FTE)
O&M	Labor	Supervisor		2,080	hours per year		$ 166.58			$ 346,500	Assumes one supervisor 40 hours per week for 52 weeks in a year (1 FTE)		

Table B-4. Cost Estimate Details: Palo Alto AWPF for TWA Flex



Focus:	**Cost Summary**
Element:	**AWPF (TWA)**
Capacity / Treatment:	**10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location:	**Palo Alto**

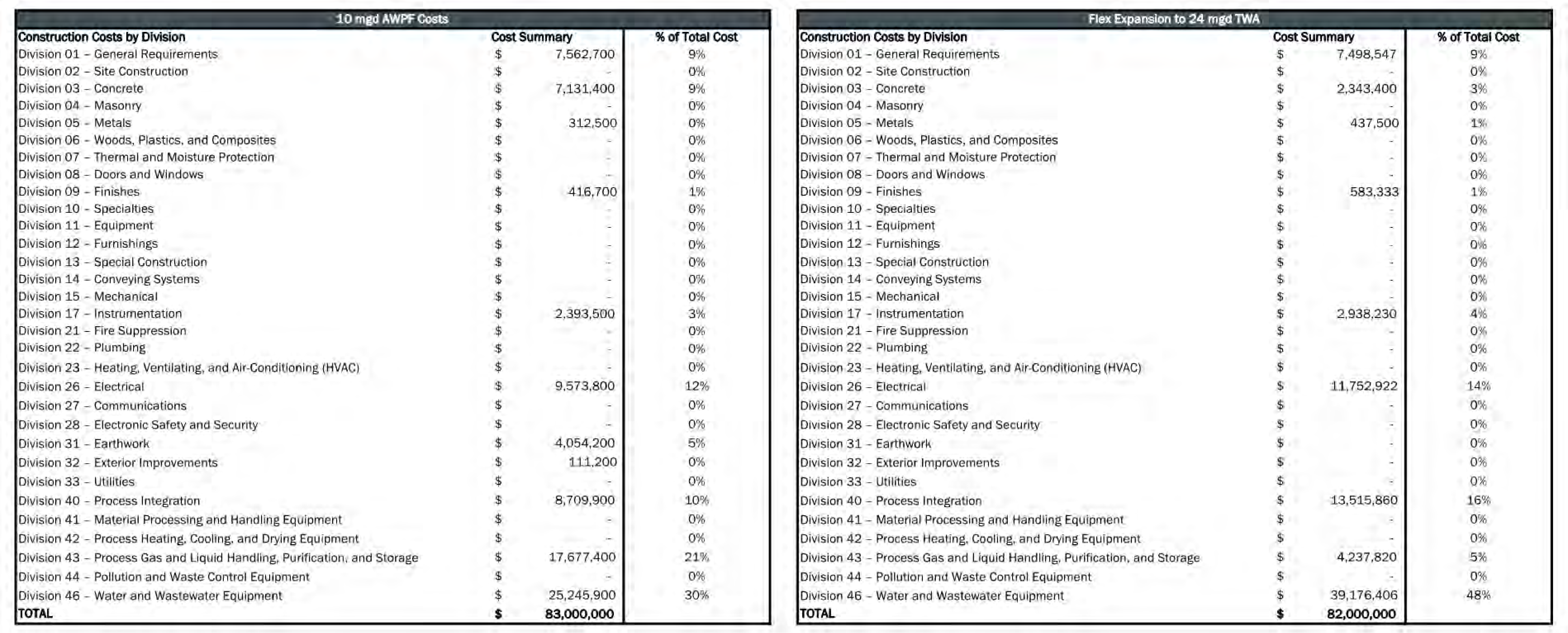
Notes

All capital costs are rounded to $1 million, and O&M costs are rounded to $100,000.

Summary

10 mgd AWPF Costs			
Capital Costs			
Raw / Construction Costs		$	83,000,000
Contingency - Treatment Facility	25%	$	21,000,000
Construction Cost Subtotal		$	104,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**125,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	17,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**195,000,000**
Annual O&M Costs			
Consumables (Equipment, Mechanical, Electrical, I&C)		$	1,110,000
Energy/Power		$	2,250,000
Chemicals		$	1,200,000
Labor		$	1,400,000
Total Annual O&M Cost		**$**	**5,960,000**

Flex Expansion to 24 mgd TWA			
Capital Costs			
Raw / Construction Costs		$	82,000,000
Contingency - Treatment Facility	25%	$	21,000,000
Construction Cost Subtotal		$	103,000,000
Tax on Materials (applied to half of subtotal)	9%	$	5,000,000
General Contractor Overhead and Profit	15%	$	16,000,000
Estimated Total Construction Cost		**$**	**124,000,000**
Owner's Reserve for Change Orders	15%	$	19,000,000
Environmental Documentation and Permits	0%	$	-
Engineering Services (Design)	15%	$	19,000,000
Construction Management	13%	$	17,000,000
Engineering Services During Construction	12%	$	15,000,000
Total Capital Cost		**$**	**194,000,000**
Annual O&M Costs			
Consumables (Equipment, Mechanical, Electrical, I&C)		$	2,540,000
Energy/Power		$	3,390,000
Chemicals		$	1,710,000
Labor		$	2,450,000
Total Annual O&M Cost		**$**	**10,090,000**



10 mgd AWPF Costs		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,562,700	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 7,131,400	9%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 312,500	0%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 416,700	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,393,500	3%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 9,573,800	12%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ 4,054,200	5%
Division 32 – Exterior Improvements	$ 111,200	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 8,709,900	10%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 17,677,400	21%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 25,245,900	30%
TOTAL	**$ 83,000,000**	

Flex Expansion to 24 mgd TWA		
Construction Costs by Division	**Cost Summary**	**% of Total Cost**
Division 01 – General Requirements	$ 7,498,547	9%
Division 02 – Site Construction	$ -	0%
Division 03 – Concrete	$ 2,343,400	3%
Division 04 – Masonry	$ -	0%
Division 05 – Metals	$ 437,500	1%
Division 06 – Woods, Plastics, and Composites	$ -	0%
Division 07 – Thermal and Moisture Protection	$ -	0%
Division 08 – Doors and Windows	$ -	0%
Division 09 – Finishes	$ 583,333	1%
Division 10 – Specialties	$ -	0%
Division 11 – Equipment	$ -	0%
Division 12 – Furnishings	$ -	0%
Division 13 – Special Construction	$ -	0%
Division 14 – Conveying Systems	$ -	0%
Division 15 – Mechanical	$ -	0%
Division 17 – Instrumentation	$ 2,938,230	4%
Division 21 – Fire Suppression	$ -	0%
Division 22 – Plumbing	$ -	0%
Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)	$ -	0%
Division 26 – Electrical	$ 11,752,922	14%
Division 27 – Communications	$ -	0%
Division 28 – Electronic Safety and Security	$ -	0%
Division 31 – Earthwork	$ -	0%
Division 32 – Exterior Improvements	$ -	0%
Division 33 – Utilities	$ -	0%
Division 40 – Process Integration	$ 13,515,860	16%
Division 41 – Material Processing and Handling Equipment	$ -	0%
Division 42 – Process Heating, Cooling, and Drying Equipment	$ -	0%
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	$ 4,237,820	5%
Division 44 – Pollution and Waste Control Equipment	$ -	0%
Division 46 – Water and Wastewater Equipment	$ 39,176,406	48%
TOTAL	**$ 82,000,000**	

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 01 – General Requirements	Mobilization	Mobilization		10%	LS			$ 75,626,500	10% of Divisions 2-47	$ 7,562,700		$ 7,498,547	10% of Divisions 2-47
Division 31 – Earthwork	Sitework	Site Clear and Grub		7	Acre		$ 7,760			$ 50,500			
Division 31 – Earthwork	Sitework	Strip Topsoil		31,460	SY		$ 0.85			$ 26,800			
Division 31 – Earthwork	Sitework	Backfill Haul to Site (3' over entire site)		31,460	CY		$ 8.88			$ 279,400			
Division 31 – Earthwork	Sitework	Backfill Placement (3' over entire site)		31,460	CY		$ 1.04			$ 32,800	This seems low, but used means est for structural backfill here		
Division 31 – Earthwork	Sitework	Excavation		39,685	CY		$ 11.78			$ 467,500			
Division 31 – Earthwork	Sitework	Compaction		15,730	CY		$ 0.89			$ 14,000			
Division 31 – Earthwork	Sitework	Grading		31,460	SY		$ 1.18			$ 37,200			
Division 31 – Earthwork	Sitework	Shoring, Sheeting, and Bracing		0	LS			$ 25,000		$ 6,300			
Division 31 – Earthwork	Sitework	Offhaul Allowance		0	LS			$ 75,000	Engineer's Estimate	$ 1,500			
Division 31 – Earthwork	Sitework	Aggregate Base		11,261	CY		$ 58.49			$ 658,700			
Division 31 – Earthwork	Sitework	Asphalt		741	SF		$ 2.01			$ 1,500			
Division 31 – Earthwork	Sitework	Gravel		10,294	SY		$ 4.63			$ 47,700			
Division 31 – Earthwork	Sitework	Site Dewatering Allowance		1	LS			$ 500,000		$ 500,000			
Division 31 – Earthwork	Sitework	Landscaping Allowance		1	LS		$ 141,455		Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 141,500			
Division 31 – Earthwork	Sitework	Lighting and Security Allowance		1	LS	$ 847,182			Estimated from SVAWPC costs; assumes proportional increase in cost with site acreage	$ 847,200			
Division 31 – Earthwork	Sitework	Utility Connections Allowance		1	LS			$ 100,000	Engineer's estimate for water, internet, sewer connections	$ 100,000			
Division 26 – Electrical	Sitework	New Electrical Service Allowance		1	LS			$ 2,000,000	Engineers estimate	$ 2,000,000			
Division 31 – Earthwork	Sitework	Subgrade Structural Piles		2,513	SF		$ 141.20		Assumes (2) 40' diameter slabs; Based on SVAWPC Schedule of Values- 14"x14" prestressed concrete piles including installation, fabrication, delivery -5ft spacing between piles	$ 354,900	Inter Process Tank		
Division 31 – Earthwork	Sitework	14-inch Waste Pipeline		1,200	LF			$ 374.46	14-inch, HDPE, 11' Cover	$ 449,400	Unit cost was obtained interpolating available data in the spreadsheet.		
Division 31 – Earthwork	Sitework	Sheeting and Shoring (Open Cut)		5%	% of			$ 449,400	9' to 14' of cover	$ 22,500	plant infrastructure		
Division 31 – Earthwork	Sitework	Potholing		12	EA		$ 1,233		Rural, $1,200 per 100 feet of pipe	$ 14,800	plant infrastructure		
Division 03 – Concrete	Concrete	EQ Basin Slab		1,481	CY		$ 645		See Site Work and Concrete Tab	$ 955,600	EQ Basin		
Division 03 – Concrete	Concrete	EQ Basin Suspended Slab		741	CY		$ 1,150		See Site Work and Concrete Tab	$ 851,900	EQ Basin		
Division 03 – Concrete	Concrete	EQ Basin Wetwell Walls		750	CY		$ 1,090		See Site Work and Concrete Tab	$ 817,500	EQ Basin		
Division 03 – Concrete	Concrete	Ozone System Slab		185	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 119,500	Added as part of TWA expansion
Division 03 – Concrete	Concrete	LOX Area Slab		88	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 56,800	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactors Slab		320	CY		$ 645		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 206,400	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Ozone Contactor Walls		576	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Ozone and LOX Area	$ 627,900	Added as part of TWA expansion
Division 03 – Concrete	Concrete	BAC Filter Slab		427	CY		$ 645		See Site Work and Concrete Tab	$ -	BAC	$ 275,200	Added as part of TWA expansion
Division 03 – Concrete	Concrete	BAC Filter Walls		300	CY		$ 1,090		See Site Work and Concrete Tab	$ -	BAC	$ 327,000	Added as part of TWA expansion
Division 03 – Concrete	Concrete	UF Reverse Filtration Pumps Slab		31	CY		$ 645		See Site Work and Concrete Tab	$ 20,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Interprocess Tanks Slab		225	CY		$ 645		See Site Work and Concrete Tab	$ 145,300	Treatment Equipment		
Division 03 – Concrete	Concrete	RO Transfer Pumps, Cartridge Filters, RO Feed Pumps Slab		211	CY		$ 645		See Site Work and Concrete Tab	$ 136,200	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Transfer Pumps Slab		53	CY		$ 645		See Site Work and Concrete Tab	$ 34,100	Treatment Equipment		
Division 03 – Concrete	Concrete	Decarbonator Towers and UV Transfer Pumps Slab		504	CY		$ 645		See Site Work and Concrete Tab	$ 324,900	Treatment Equipment		
Division 03 – Concrete	Concrete	Chlorine Contact Basin Slab		538	CY		$ 645		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 346,900	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chlorine Contact Basin Walls, including interior channel Walls		233	CY		$ 1,090		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 253,600	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chlorine Contact Basin Suspended Slab		202	CY		$ 645		See Site Work and Concrete Tab	$ -	Treatment Equipment	$ 130,100	Added as part of TWA expansion
Division 03 – Concrete	Concrete	Chemical Storage Area Slab		813	CY		$ 645		See Site Work and Concrete Tab	$ 524,600	Chemical Storage		
Division 03 – Concrete	Concrete	Chemical Storage Area Walls		72	CY		$ 1,090		See Site Work and Concrete Tab	$ 78,300	Chemical Storage		
Division 03 – Concrete	Concrete	Slab for Process Building		4,515	CY		$ 645		See Site Work and Concrete Tab	$ 2,912,200	Process Building		
Division 03 – Concrete	Concrete	Switchgear Slab		46	CY		$ 645		See Site Work and Concrete Tab	$ 29,900	Electrical		

Brown AND Caldwell

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 03 – Concrete	Concrete	Transformer Slab		36	CY		$ 645		See Site Work and Concrete Tab	$ 23,000	Electrical		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Slab		66	CY		$ 645		See Site Work and Concrete Tab	$ 42,900	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Waste Equalization Wetwell Walls		200	CY		$ 1,090		See Site Work and Concrete Tab	$ 218,000	Waste Equalization Wetwell & Pump Station		
Division 03 – Concrete	Concrete	Piping Slab		26	CY		$ 645		See Site Work and Concrete Tab	$ 16,900	Waste Equalization Wetwell & Pump Station		
Division 32 – Exterior Improvements	Exterior	Chain Link Fence Around AWPF		2,100	LF		$ 53			$ 111,200			
Division 05 – Metals	Metals	Misc. Metals Allowance		1	LS			$ 312,500	Engineer's Estimate	$ 312,500	Scaled down from the 24 MGD facility	$ 437,500	Scaled down from the 24 MGD facility
Division 09 – Finishes	Finishes	Coating Allowance		1	LS			$ 416,667	Engineer's Estimate	$ 416,700	Scaled down from the 24 MGD facility	$ 583,333	Scaled down from the 24 MGD facility
Division 46 – Water and Wastewater Equipment	Equipment	Ozone System		1	EA	$ 7,455,890			Proposal from Wedeco. Costs includes ozone generators, LOX system, injection skids, reaction systems, destruct units, cooling systems, Nitrogen boost skid, ozone control panel, and pumps.	$ -		$ 7,455,900	Added as part of TWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	BAC System		1	EA	$ 5,741,624			Scaled up from Flagstaff Study. Costs includes scour blowers, centrifugal pumps, chemical metering pumps, chemical totes, GAC media, underdrain system, and sand media.	$ -		$ 5,741,700	Added as part of TWA expansion
Division 46 – Water and Wastewater Equipment	Equipment	Influent Pumps (to feed UF)	150	4	ea	$ 59,665			Interpolate from feed pumps on equip page	$ 238,700		$ 238,700	4 pumps for 10 mgd (3 duty and 1 active), add another 4 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Ultrafiltration Treatment		1	LS	$ 4,377,554			October 2019 Pall Proposal includes filter skids, strainers, reverse filtration pumps, CIP equipment, air equipment	$ 4,377,600	Filtration Treatment	$ 5,745,539	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	RO Flush Tank	12,000	1				$84,000	Based on July 2016 So. SF quote for FRP tank; $7 per gal including appurtenances	$ 84,000			
Division 46 – Water and Wastewater Equipment	Equipment	RO Transfer Pumps	200	3	EA	$ 71,786				$ 215,400	Filtration Treatment / Equipment cost linearly interpolated based on 40 HP and 200 HP vendor estimates	$ 143,600	3 pumps for 10 mgd (2 duty and 1 active), add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Reverse Osmosis		1	EA	$ 13,042,857			Proposal from Pall includes cartridge filters, RO feed pumps, RO Skids, CIP equipment, CIP chemical pumps, Control panel, and startup	$ 13,042,900	Filtration Treatment	$ 16,434,000	Costs from the 14 mgd Palo Alto AWPF.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator Transfer Pumps	25	2	EA	$ 29,364				$ 58,800	Filtration Treatment	$ 58,800	2 pumps for 10 mgd, add another 2 pumps for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Decarbonator		1	EA	$ 756,875			5/4/17 proposal from Daniel Mechanical includes (4) decarbonator towers, flow distributor system, media, fan system	$ 756,900	Filtration Treatment	$ 756,900	2 decarbonators for 10 mgd, add another 2 decarbonators for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV/AOP Transfer Pumps	50	2	EA	$ 35,424				$ 70,900	UV/AOP	$ 35,424	2 pumps for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV Influent Flowmeters	18	2	EA	$ 9,315			Assumed 18" flowmeter	$ 18,700	UV/AOP	$ 9,315	2 meters for 10 mgd, add another 1 pump for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	Static Mixers		2	EA		$ 12,132			$ 24,300	UV/AOP	$ 12,132	2 mixers for 10 mgd, add another 1 mixer for 14 mgd expansion.
Division 46 – Water and Wastewater Equipment	Equipment	UV System		1	EA	$ 4,532,826			2 duty, 1 standby 12mgd rated. Package includes reactors, ballasts, UV lamps, chemical feed/static mixing system	$ 4,532,900	UV/AOP	$ 2,544,395	UV/AOP, scaled costs down from Palo Alto 14 mgd AWPF based on assumption of only needing one (1) 14 mgd reactors.
Division 46 – Water and Wastewater Equipment	Equipment	Lime System		1	EA	$ 1,222,965			Package includes one (1) Merrick Hydrated Lime Storage Silo with High Density Lime Slurry Continuous Production and Metering System	$ 1,223,000	Lime System		
Division 46 – Water and Wastewater Equipment	Equipment	Hydrogen Peroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hydroxide Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		

Focus:	**Cost Inputs and R&R**
Aspect:	**AWPF (TWA)**
Capacity:	**10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location:	**Palo Alto**

Date:	2/5/2020
BC Project Number:	151772
Estimate Version Number:	2.0
Estimate Date:	R. Guillen
Checked By:	D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Hypochlorite Metering Pumps		4	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 150,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Aq. Ammonia Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Sodium Bisulfite Metering Pumps		2	EA	$ 37,500			Diaphragm pump, includes valves and appurtenances	$ 75,000	Chemical Dosing		
Division 46 – Water and Wastewater Equipment	Equipment	Waste Equalization Pumps	10	4	EA	$ 37,950				$ 151,800	Additional Pumping Requirements		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Process Building		60,950	SF		$ 219		265' x 230'; furnished and installed	$ 13,322,400	Process Building		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Interprocess Storage Tank, 375,000 gallons		0.4	EA		$ 534,375		Need two tanks (approx 82,900 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at ultimate flows	$ 236,300	Storage Tanks	$ 271,320	Need two addional tanks (approx 95,200 gallons each), assume scaled down costs based on costs for a 375,000 steel tank, assumes 15 minutes of feed to the RO system at
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Purified Water Storage Clearwell	4	1	EA	$ 3,650,000			From DN Tanks cost proposal, need one 4 MG tank for 10 mgd	$ 3,650,000	Prestressed Concrete Tanks	$ 3,650,000	Need an additional 4 MG tank for 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Chemical Storage Area Canopy		1,412	SF	$ 108				$ 152,200	Canopies for citric acid and sodium bisulfite storage in UF CIP area, estimated from SVAWPC canopy costs (assumes linear interpolation of unit cost based on 454 sf)		
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	RO Antiscalant (HDXLPE, Vert.)	1,100	1	EA	$ 4,310			Assumes 30 day storage	$ 4,400	Chemical Tanks	$ 4,400	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Hydrogen Peroxide Tank (HDPE, Vert.)	2,500	1	EA	$ 12,275			Assumes 30 day storage	$ 12,300	Chemical Tanks	$ 12,300	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Bisulfite Tank (HDXLPE, Vert.)	2,000	1	EA	$ 5,793			Assumes 30 day storage	$ 5,800	Chemical Tanks	$ 5,800	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hydroxide Tank (Carbon Steel, Vert.)	4,000	1	EA	$ 48,000			Assumes 30 day storage	$ 48,000	Chemical Tanks	$ 48,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sodium Hypochlorite Tank (FRP, Vert.)	21,000	1	EA	$ 220,500			Assumes 7 day storage	$ 220,500	Chemical Tanks	$ 220,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Sulfuric Acid Tank (Lined Steel, Vert.)	1,120	1	EA	$ 13,440			Assumes 30 day storage	$ 13,500	Chemical Tanks	$ 13,500	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 43 – Process Gas and Liquid Handling, Purification, and Storage	Special Construction	Aqueous Ammonia Tank (Horz. Carbon Steel)	1,000	1	EA	$ 12,000			Assumes 30 day storage	$ 12,000	Chemical Tanks	$ 12,000	Added another tank to accommodate additional storage needed for the 14 mgd.
Division 40 – Process Integration	Mechanical	Piping allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 11,752,922	30% of Equipment Costs
Division 40 – Process Integration	Mechanical	Valve allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Fitting allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 40 – Process Integration	Mechanical	Supports allowance		5%	% of			$ 7,573,800	5% of Piping Allowance	$ 378,700		$ 587,646	5% of Piping Allowance
Division 26 – Electrical	Electrical	Electrical Allowance		30%	% of			$ 25,245,900	30% of Equipment Costs	$ 7,573,800		$ 11,752,922	30% of Equipment Costs
Division 17 – Instrumentation	I&C	I&C Allowance		25%	% of			$ 9,573,800	25% of Electrical Costs	$ 2,393,500		$ 2,938,230	25% of Electrical Costs
O&M	Consumables	Granular Activated Carbon Media Replacement		17,280	CF		$ 61		Based on replacement every 2 years	$ -		$ 1,046,200	Added as part of TWA expansion
O&M	Consumables	UF Membranes Replacement		338	Membranes/yr		$ 1,980		Based on a typical membrane life of 3 years	$ 668,400		$ 935,672	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
O&M	Consumables	RO Membranes Replacement		385	Membranes/yr		$ 347		Based on a typical membrane life of 5 years	$ 133,700	installation costs must be covered by O&M labor	$ 187,101	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Lamp Replacement		175	Lamps/yr		$ 196		Based on 12,000 hour replacement frequency	$ 34,400	installation costs must be covered by O&M labor	$ 48,067	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	UV Ballast Replacement		24	Ballast/yr		$ 794		Based on 5 year replacement frequency	$ 19,100	installation costs must be covered by O&M labor	$ 26,679	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Consumables	Pumping Equipment Consumables		2%	% of			$ 946,900	2% of Pumping Equipment Cost	$ 19,000		$ 4,756	2% of Pumping Equipment Cost
O&M	Consumables	Electrical Consumables		2%	% of			$ 9,573,800	2% of Electrical Cost	$ 191,500		$ 235,058	2% of Electrical Cost
O&M	Consumables	Instrumentation Consumables		2%	% of			$ 2,393,500	2% of Instrumentation & Controls Cost	$ 47,900		$ 58,765	2% of Instrumentation & Controls Cost
O&M	Power	Influent Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Ozone generator		2,810,500	kWh		$ 0.10			$ -		$ 290,800	Added as part of TWA expansion
O&M	Power	Ozone cooling water pumps		143,769	kWh		$ 0.10			$ -		$ 14,900	Added as part of TWA expansion
O&M	Power	Ozone destruct heater		210,240	kWh		$ 0.10			$ -		$ 21,800	Added as part of TWA expansion
O&M	Power	Ozone destruct blower		294,073	kWh		$ 0.10			$ -		$ 30,500	Added as part of TWA expansion
O&M	Power	GAC backwash pumps		114,362	kWh		$ 0.10			$ -		$ 11,900	Added as part of TWA expansion
O&M	Power	BAC air scour blowers		37,794	kWh		$ 0.10			$ -		$ 4,000	Added as part of TWA expansion
O&M	Power	UF Air Scour		4,271	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 500		$ 619	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UF CIP		5,585	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 600		$ 809	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Transfer Pumps		2,178,320	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 225,400		$ 315,495	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Feed Pumps		13,614,500	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 1,408,500		$ 1,774,659	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Inter-Stage Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO CIP		984	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 200		$ 143	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Feed Pumps		272,290	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 28,200		$ 39,437	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Decarbonator Blowers		217,832	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 22,600		$ 31,549	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV/AOP Transfer Pumps		544,580	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 56,400		$ 78,874	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	UV System		1,825,000	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 188,900		$ 264,322	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	RO Concentrate Waste Pumps		490,122	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 50,800		$ 106,480	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Waste Equalization Pumps		81,687	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 8,500		$ 47,324	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Power	Chemical Metering Pumps		19,060	kWh		$ 0.10		Scaled back for 10 mgd AWPF, original costs were developed for 24 mgd AWPF	$ 2,000		$ 2,761	Scaled back for 14 mgd AWPF, original costs were developed for 24 mgd AWPF
O&M	Chemicals	Liquid Oxygen		584,000	lb			$ 0.04	Ozone design feed is 1,600 lb/day. Per DC Timan estimate, cost is $72 per ton	$ -		$ 21,100	Added as part of TWA expansion

Focus: **Cost Inputs and R&R**
Aspect: **AWPF (TWA)**
Capacity: **10 mgd GWR with Flex Expansion to 24 mgd TWA**
Location: **Palo Alto**

Date: 2/5/2020
BC Project Number: 151772
Estimate Version Number: 2.0
Estimate Date: R. Guillen
Checked By: D. Mulacek

Division and O&M	Name	Asset ID (Description)	Size	Quantity	Unit	Cost Method				10 mgd Near-term Project		14 mgd Flex Expansion	
						A: Equipment	B: Adjusted Unit	C: Project-Specific	Cost Method C: Assumptions	Cost	Notes	Additional costs	Notes
O&M	Chemicals	Sodium Bisulfite		21,500	gal		$ 2.25		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 48,400		$ 67,713	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Aq. Ammonia		12,917	gal		$ 0.10		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 1,300		$ 1,761	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Citric Acid		1,500	gal		$ 5.57		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 8,400		$ 11,697	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Hydrogen Peroxide		25,000	gal		$ 5.14		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 128,500		$ 179,812	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hydroxide		40,000	gal		$ 2.88		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 115,400		$ 161,444	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF
O&M	Chemicals	Sodium Hypochlorite		880,833	gal		$ 0.61		Scaled back for 10 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF	$ 537,400		$ 752,236	Scaled back for 14 mgd AWPF, original costs based on Expedited Purified Water Program Estimates for 24 mgd AWPF

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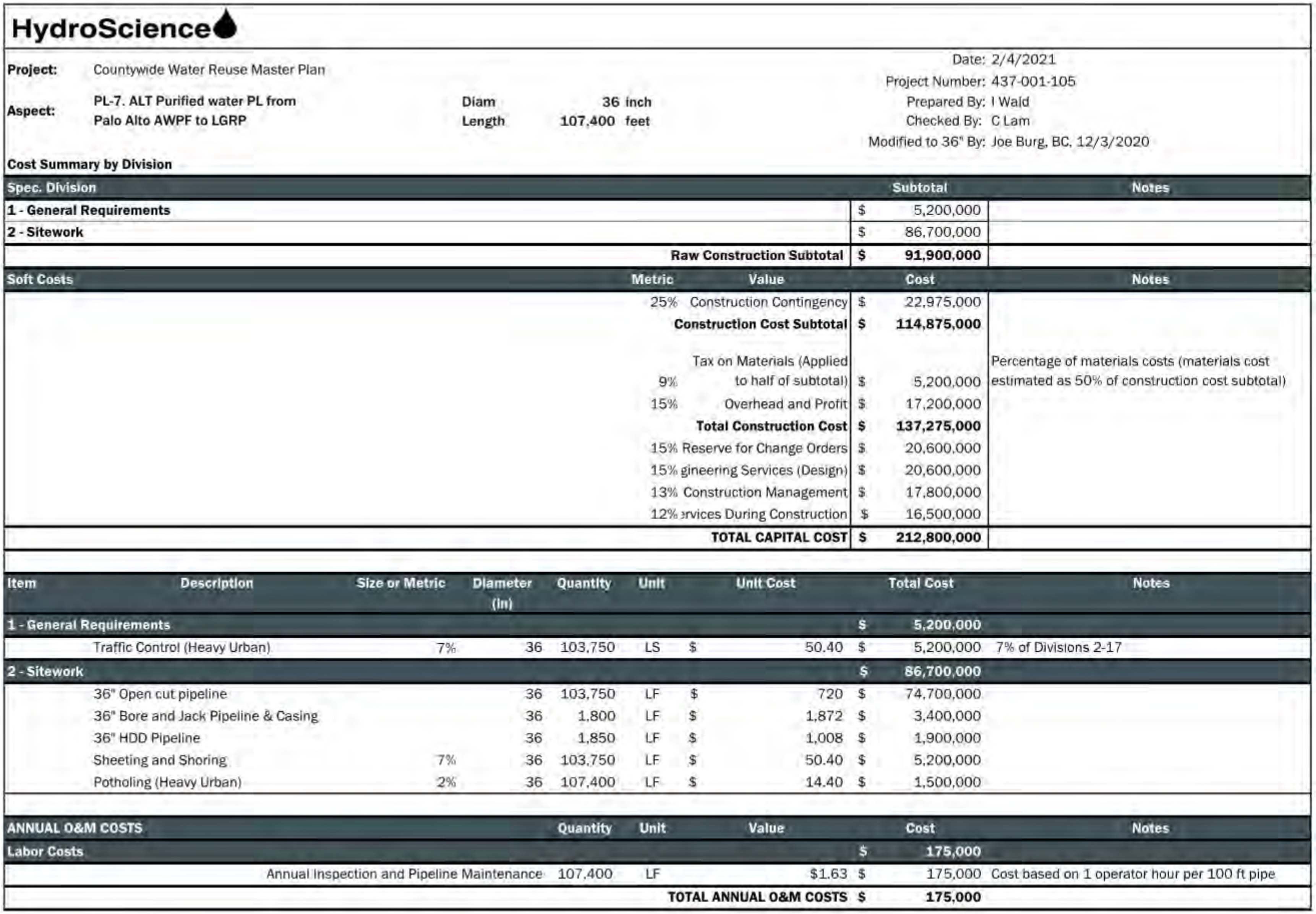
Table B-5. Cost Estimate Details for PL-7 ALT: 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-7. ALT Purified water PL from Palo Alto AWPF to LGRP

Diam 36 inch
Length 107,400 feet

Date: 2/4/2021
Project Number: 437-001-105
Prepared By: I Wald
Checked By: C Lam
Modified to 36" By: Joe Burg, BC, 12/3/2020

Cost Summary by Division

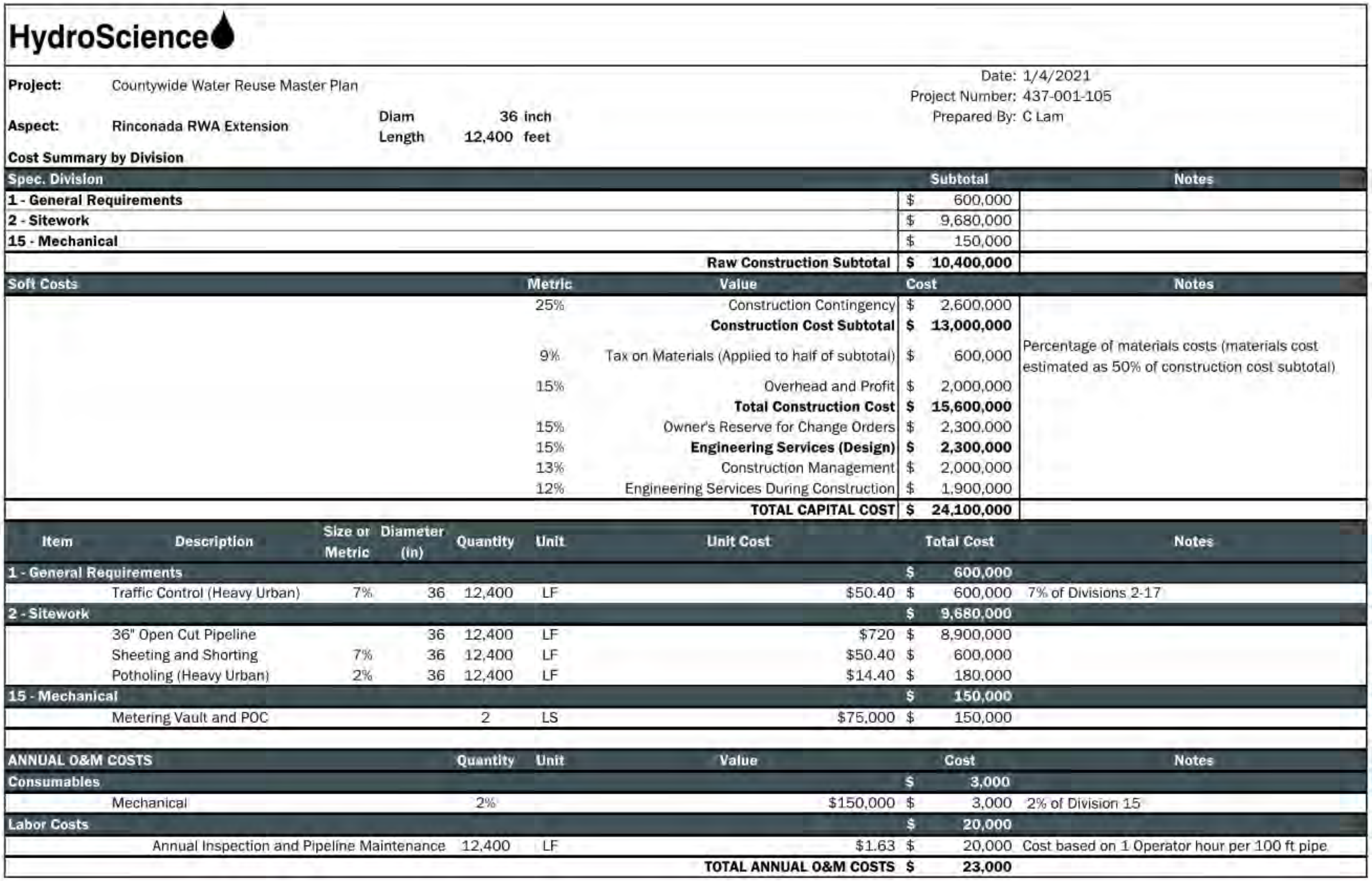
Spec. Division		Subtotal	Notes
1 - General Requirements	$	5,200,000	
2 - Sitework	$	86,700,000	
Raw Construction Subtotal	**$**	**91,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	22,975,000	
		Construction Cost Subtotal	**$**	**114,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	5,200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	17,200,000	
		Total Construction Cost	**$**	**137,275,000**	
	15%	Reserve for Change Orders	$	20,600,000	
	15%	gineering Services (Design)	$	20,600,000	
	13%	Construction Management	$	17,800,000	
	12%	ervices During Construction	$	16,500,000	
		TOTAL CAPITAL COST	**$**	**212,800,000**	

Item	Description	Size or Metric	Diameter (In)	Quantity	Unit		Unit Cost		Total Cost	Notes
1 - General Requirements								**$**	**5,200,000**	
	Traffic Control (Heavy Urban)	7%	36	103,750	LS	$	50.40	$	5,200,000	7% of Divisions 2-17
2 - Sitework								**$**	**86,700,000**	
	36" Open cut pipeline		36	103,750	LF	$	720	$	74,700,000	
	36" Bore and Jack Pipeline & Casing		36	1,800	LF	$	1,872	$	3,400,000	
	36" HDD Pipeline		36	1,850	LF	$	1,008	$	1,900,000	
	Sheeting and Shoring	7%	36	103,750	LF	$	50.40	$	5,200,000	
	Potholing (Heavy Urban)	2%	36	107,400	LF	$	14.40	$	1,500,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				**$**	**175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$	175,000	Cost based on 1 operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**175,000**	

Table B-6. Cost Estimate Details for Rinconada Extension: 36-inch Purified Water Pipeline from LGRP to Rinconada WTP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: Rinconada RWA Extension

Diam 36 inch
Length 12,400 feet

Date: 1/4/2021
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 600,000	
2 - Sitework	$ 9,680,000	
15 - Mechanical	$ 150,000	
Raw Construction Subtotal	**$ 10,400,000**	

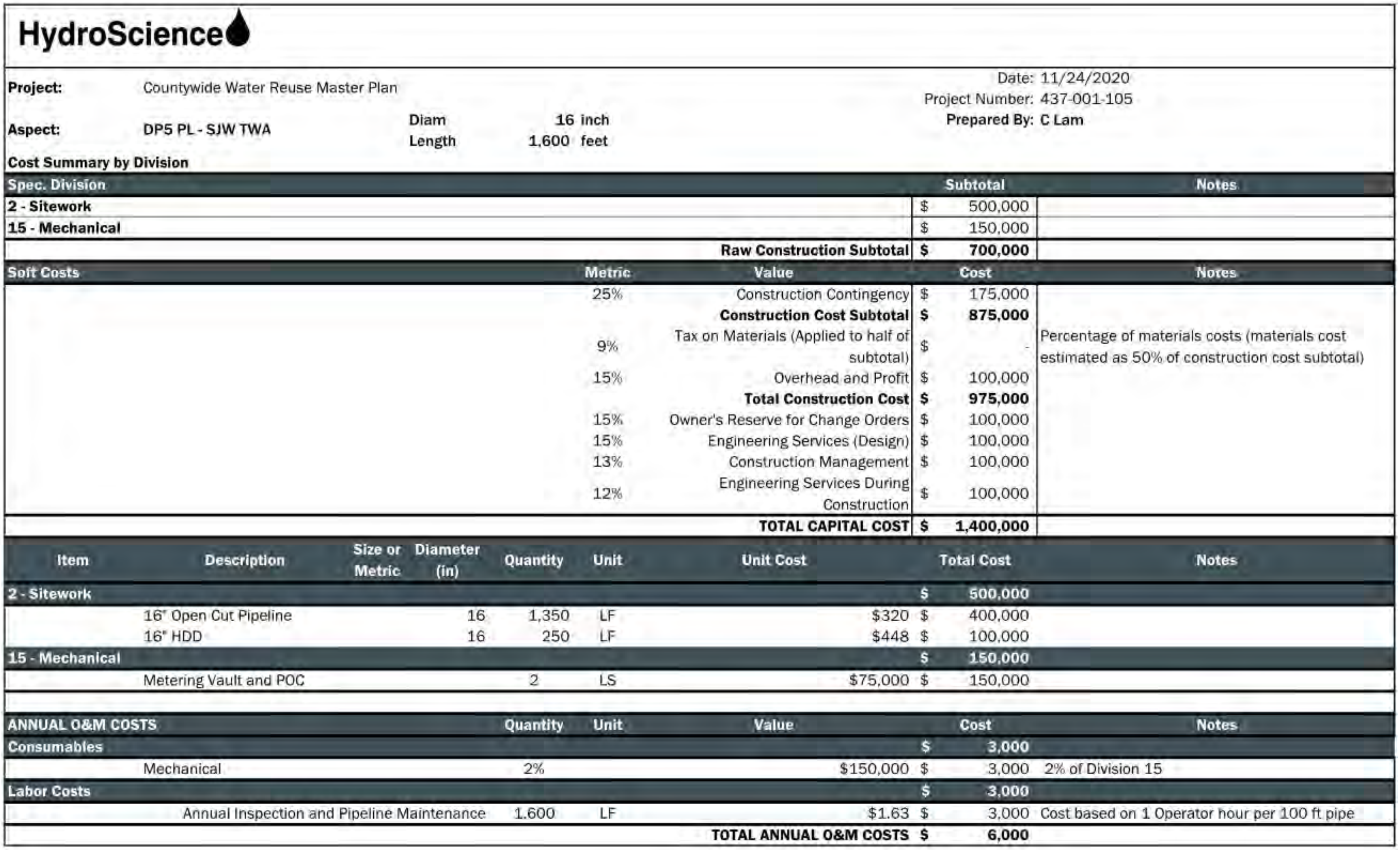
Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,600,000	
		Construction Cost Subtotal	**$ 13,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,000,000	
		Total Construction Cost	**$ 15,600,000**	
	15%	Owner's Reserve for Change Orders	$ 2,300,000	
	15%	**Engineering Services (Design)**	**$ 2,300,000**	
	13%	Construction Management	$ 2,000,000	
	12%	Engineering Services During Construction	$ 1,900,000	
		TOTAL CAPITAL COST	**$ 24,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	36	12,400	LF	$50.40	$ 600,000	7% of Divisions 2-17
2 - Sitework							**$ 9,680,000**	
	36" Open Cut Pipeline		36	12,400	LF	$720	$ 8,900,000	
	Sheeting and Shorting	7%	36	12,400	LF	$50.40	$ 600,000	
	Potholing (Heavy Urban)	2%	36	12,400	LF	$14.40	$ 180,000	
15 - Mechanical							**$ 150,000**	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Consumables				**$ 3,000**	
Mechanical	2%		$150,000	$ 3,000	2% of Division 15
Labor Costs				**$ 20,000**	
Annual Inspection and Pipeline Maintenance	12,400	LF	$1.63	$ 20,000	Cost based on 1 Operator hour per 100 ft pipe
TOTAL ANNUAL O&M COSTS				**$ 23,000**	

Brown AND Caldwell

Table B-7. Cost Estimate Details for DP5 PL (SJW TWA): 16-inch Purified Water Pipeline from GWR Alignment to SJ Water Campbell Delivery Point



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP5 PL - SJW TWA

Diam 16 inch
Length 1,600 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

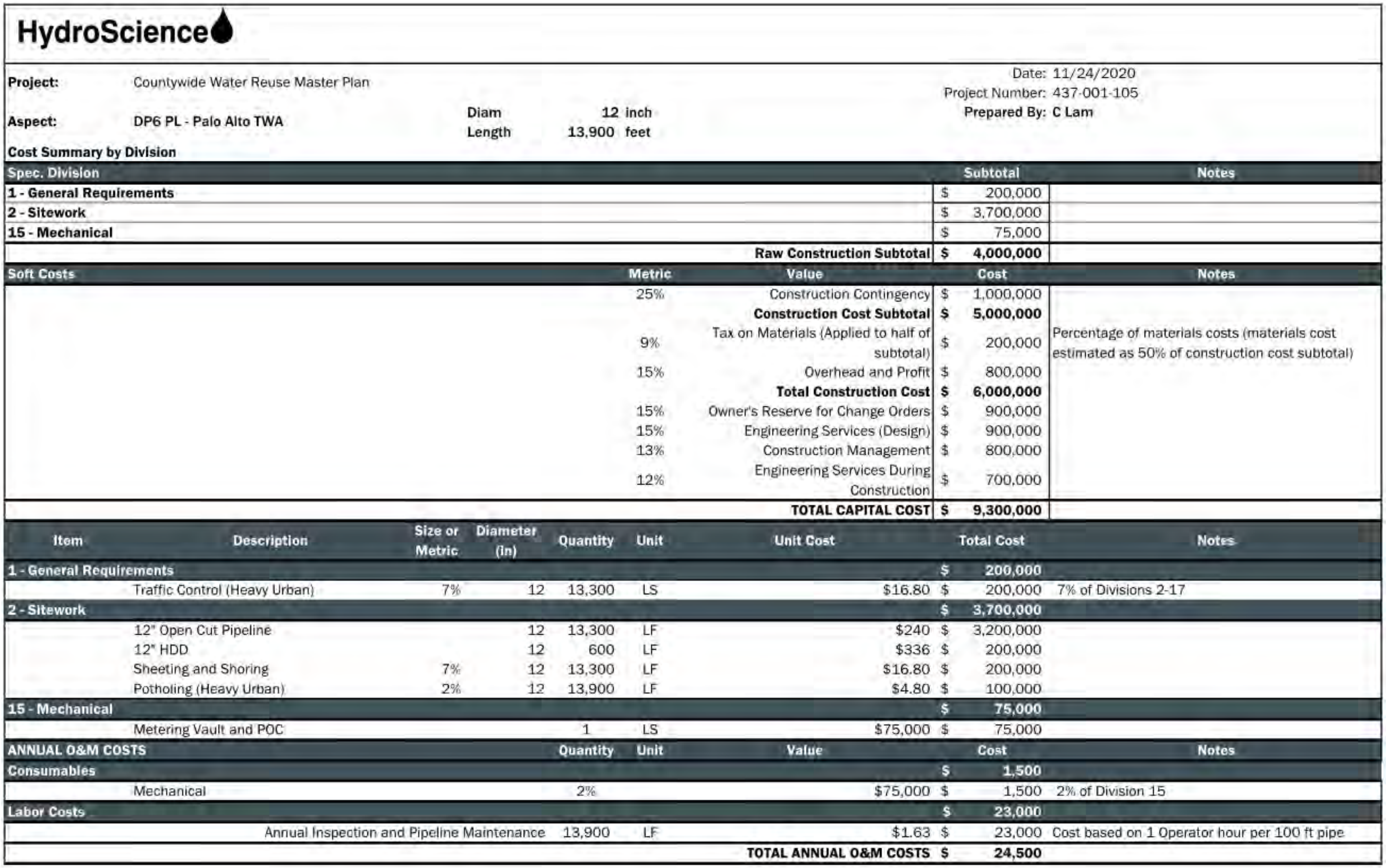
Spec. Division	Subtotal	Notes
2 - Sitework	$ 500,000	
15 - Mechanical	$ 150,000	
Raw Construction Subtotal	**$ 700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 175,000	
		Construction Cost Subtotal	**$ 875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ -	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 100,000	
		Total Construction Cost	**$ 975,000**	
	15%	Owner's Reserve for Change Orders	$ 100,000	
	15%	Engineering Services (Design)	$ 100,000	
	13%	Construction Management	$ 100,000	
	12%	Engineering Services During Construction	$ 100,000	
		TOTAL CAPITAL COST	**$ 1,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
2 - Sitework							**$ 500,000**	
	16" Open Cut Pipeline		16	1,350	LF	$320	$ 400,000	
	16" HDD		16	250	LF	$448	$ 100,000	
15 - Mechanical							**$ 150,000**	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 3,000**	
	Mechanical	2%		$150,000	$ 3,000	2% of Division 15
Labor Costs					**$ 3,000**	
	Annual Inspection and Pipeline Maintenance	1,600	LF	$1.63	$ 3,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 6,000**	

Table B-8. Cost Estimate Details for DP6 PL (Palo Alto TWA): 12-inch Purified Water Pipeline from GWR Alignment to Palo Alto Delivery Point



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP6 PL - Palo Alto TWA

Diam 12 inch
Length 13,900 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 200,000	
2 - Sitework		$ 3,700,000	
15 - Mechanical		$ 75,000	
	Raw Construction Subtotal	**$ 4,000,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,000,000	
		Construction Cost Subtotal	**$ 5,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 800,000	
		Total Construction Cost	**$ 6,000,000**	
	15%	Owner's Reserve for Change Orders	$ 900,000	
	15%	Engineering Services (Design)	$ 900,000	
	13%	Construction Management	$ 800,000	
	12%	Engineering Services During Construction	$ 700,000	
		TOTAL CAPITAL COST	**$ 9,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 200,000**	
	Traffic Control (Heavy Urban)	7%	12	13,300	LS	$16.80	$ 200,000	7% of Divisions 2-17
2 - Sitework							**$ 3,700,000**	
	12" Open Cut Pipeline		12	13,300	LF	$240	$ 3,200,000	
	12" HDD		12	600	LF	$336	$ 200,000	
	Sheeting and Shoring	7%	12	13,300	LF	$16.80	$ 200,000	
	Potholing (Heavy Urban)	2%	12	13,900	LF	$4.80	$ 100,000	
15 - Mechanical							**$ 75,000**	
	Metering Vault and POC			1	LS	$75,000	$ 75,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 1,500**	
	Mechanical	2%		$75,000	$ 1,500	2% of Division 15
Labor Costs					**$ 23,000**	
	Annual Inspection and Pipeline Maintenance	13,900	LF	$1.63	$ 23,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 24,500**	

Table B-9. Cost Estimate Details for DP7 PL (Mountain View/Whisman TWA): 12-inch Purified Water Pipeline from GWR Alignment to Mountain View Whisman Delivery Point

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP7 PL - Mountain View/Whisman TWA

Diam 12 inch
Length 5,300 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

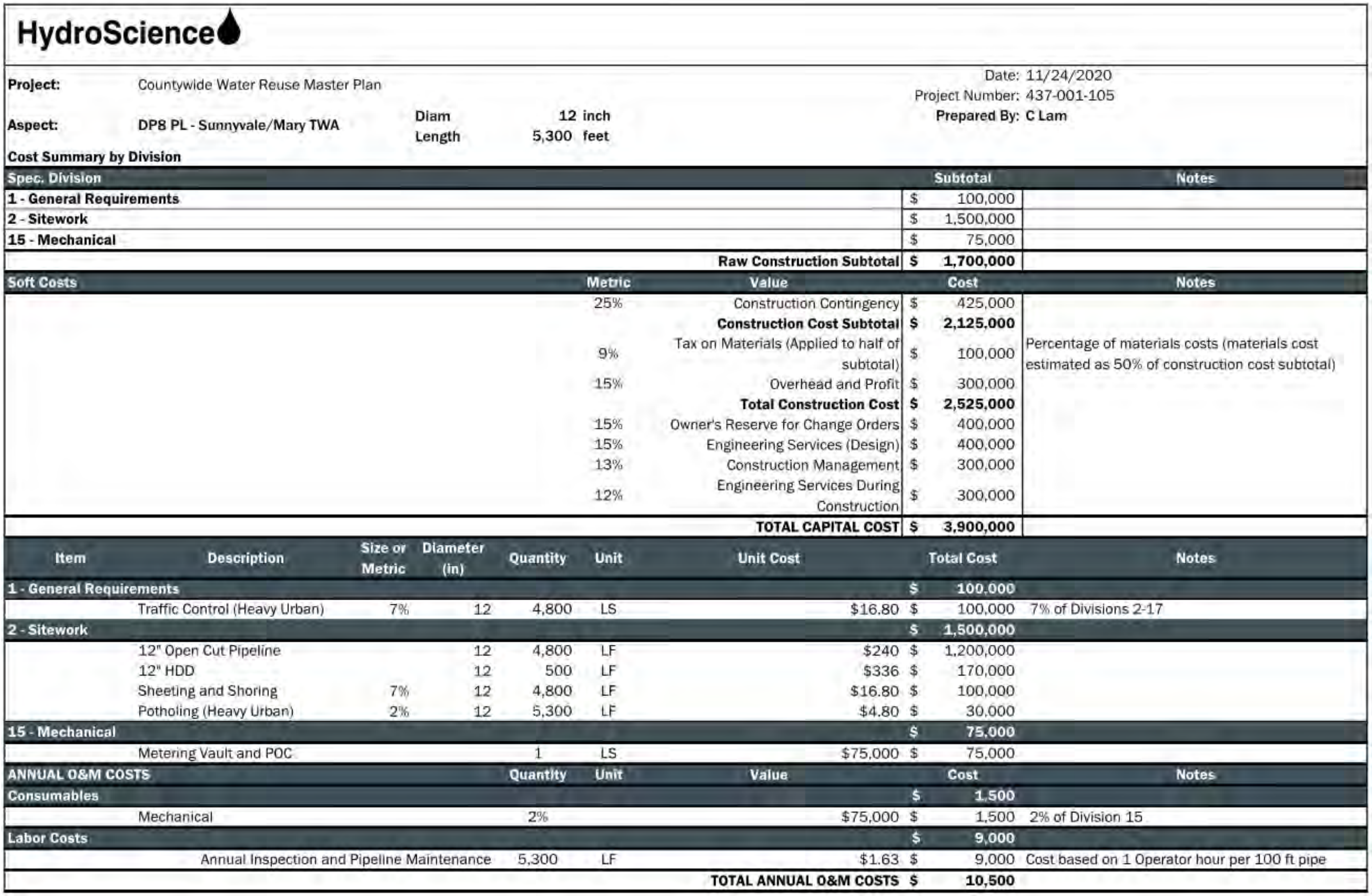
Spec. Division		Subtotal	Notes
1 - General Requirements	$	100,000	
2 - Sitework	$	1,400,000	
15 - Mechanical	$	75,000	
Raw Construction Subtotal	**$**	**1,600,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	400,000	
		Construction Cost Subtotal	**$**	**2,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	300,000	
		Total Construction Cost	**$**	**2,400,000**	
	15%	Owner's Reserve for Change Orders	$	400,000	
	15%	Engineering Services (Design)	$	400,000	
	13%	Construction Management	$	300,000	
	12%	Engineering Services During Construction	$	300,000	
		TOTAL CAPITAL COST	**$**	**3,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**100,000**	
	Traffic Control (Heavy Urban)	7%	12	5,100	LS	$16.80	$	100,000	7% of Divisions 2-17
2 - Sitework							**$**	**1,400,000**	
	12" Open Cut Pipeline		12	5,100	LF	$240	$	1,200,000	
	12" HDD		12	200	LF	$336	$	70,000	
	Sheeting and Shoring	7%	12	5,100	LF	$16.80	$	100,000	
	Potholing (Heavy Urban)	2%	12	5,300	LF	$4.80	$	30,000	
15 - Mechanical							**$**	**75,000**	
	Metering Vault and POC			1	LS	$75,000	$	75,000	

ANNUAL O&M COSTS		Quantity	Unit	Value		Cost	Notes
Consumables					**$**	**1,500**	
	Mechanical	2%		$75,000	$	1,500	2% of Division 15
Labor Costs					**$**	**9,000**	
	Annual Inspection and Pipeline Maintenance	5,300	LF	$1.63	$	9,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$**	**10,500**	

Table B-10. Cost Estimate Details for DP8 PL (Sunnyvale/Mary TWA): 12-inch Purified Water Pipeline from GWR Alignment to Sunnyvale Mary Delivery Point



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP8 PL - Sunnyvale/Mary TWA

Diam 12 inch
Length 5,300 feet

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

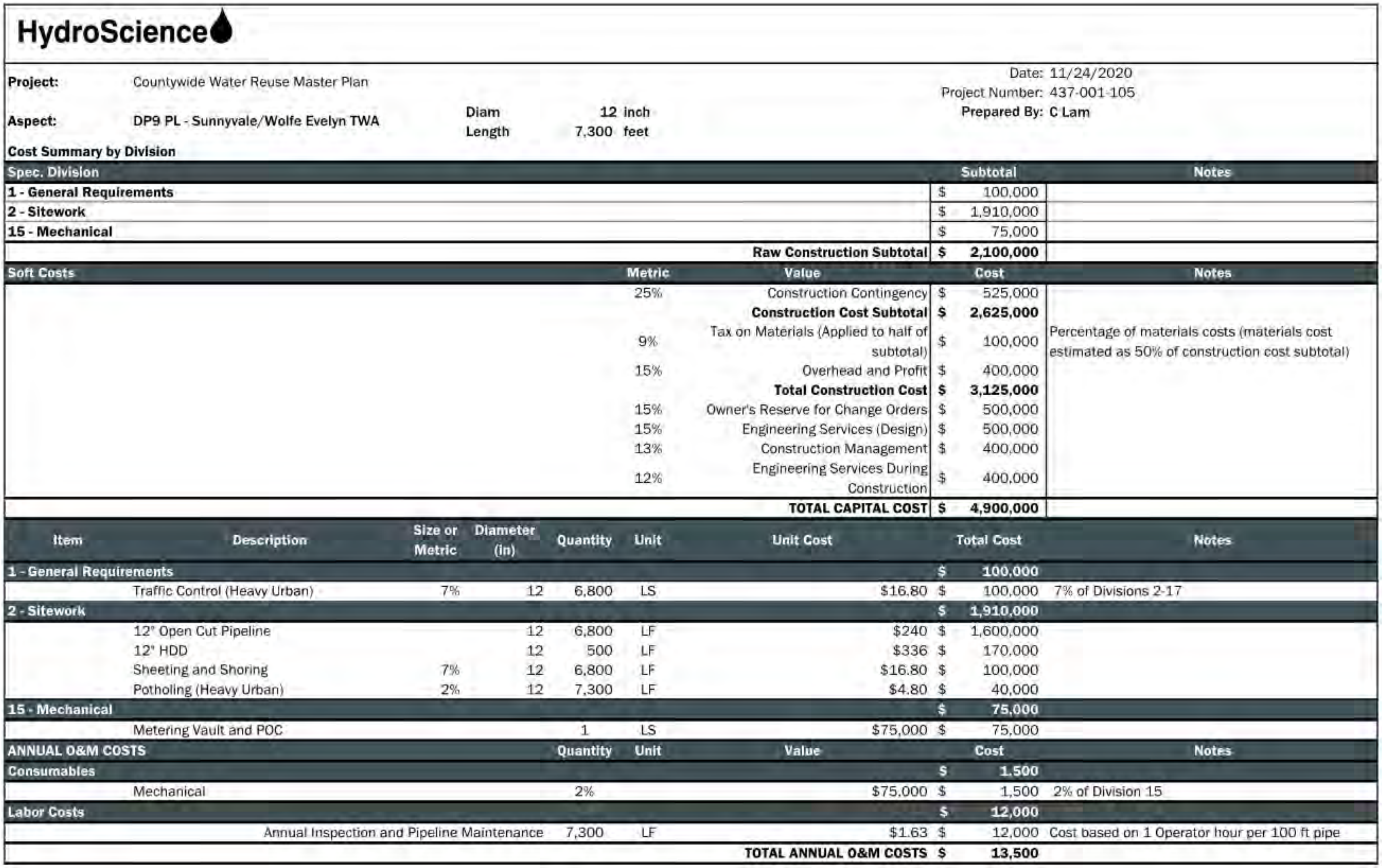
Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	100,000	
2 - Sitework	$	1,500,000	
15 - Mechanical	$	75,000	
Raw Construction Subtotal	**$**	**1,700,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	425,000	
		Construction Cost Subtotal	**$**	**2,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	300,000	
		Total Construction Cost	**$**	**2,525,000**	
	15%	Owner's Reserve for Change Orders	$	400,000	
	15%	Engineering Services (Design)	$	400,000	
	13%	Construction Management	$	300,000	
	12%	Engineering Services During Construction	$	300,000	
		TOTAL CAPITAL COST	**$**	**3,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							**$**	**100,000**	
	Traffic Control (Heavy Urban)	7%	12	4,800	LS	$16.80	$	100,000	7% of Divisions 2-17
2 - Sitework							**$**	**1,500,000**	
	12" Open Cut Pipeline		12	4,800	LF	$240	$	1,200,000	
	12" HDD		12	500	LF	$336	$	170,000	
	Sheeting and Shoring	7%	12	4,800	LF	$16.80	$	100,000	
	Potholing (Heavy Urban)	2%	12	5,300	LF	$4.80	$	30,000	
15 - Mechanical							**$**	**75,000**	
	Metering Vault and POC			1	LS	$75,000	$	75,000	
ANNUAL O&M COSTS				**Quantity**	**Unit**	**Value**		**Cost**	**Notes**
Consumables							**$**	**1,500**	
	Mechanical			2%		$75,000	$	1,500	2% of Division 15
Labor Costs							**$**	**9,000**	
	Annual Inspection and Pipeline Maintenance			5,300	LF	$1.63	$	9,000	Cost based on 1 Operator hour per 100 ft pipe
						TOTAL ANNUAL O&M COSTS	**$**	**10,500**	

Table B-11. Cost Estimate Details for DP8 PL (Sunnyvale TWA): 12-inch Purified Water Pipeline from GWR Alignment to Sunnyvale/Wolfe Evelyn/Central Delivery Point



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: DP9 PL - Sunnyvale/Wolfe Evelyn TWA

Diam 12 **inch**
Length 7,300 **feet**

Date: 11/24/2020
Project Number: 437-001-105
Prepared By: C Lam

Cost Summary by Division

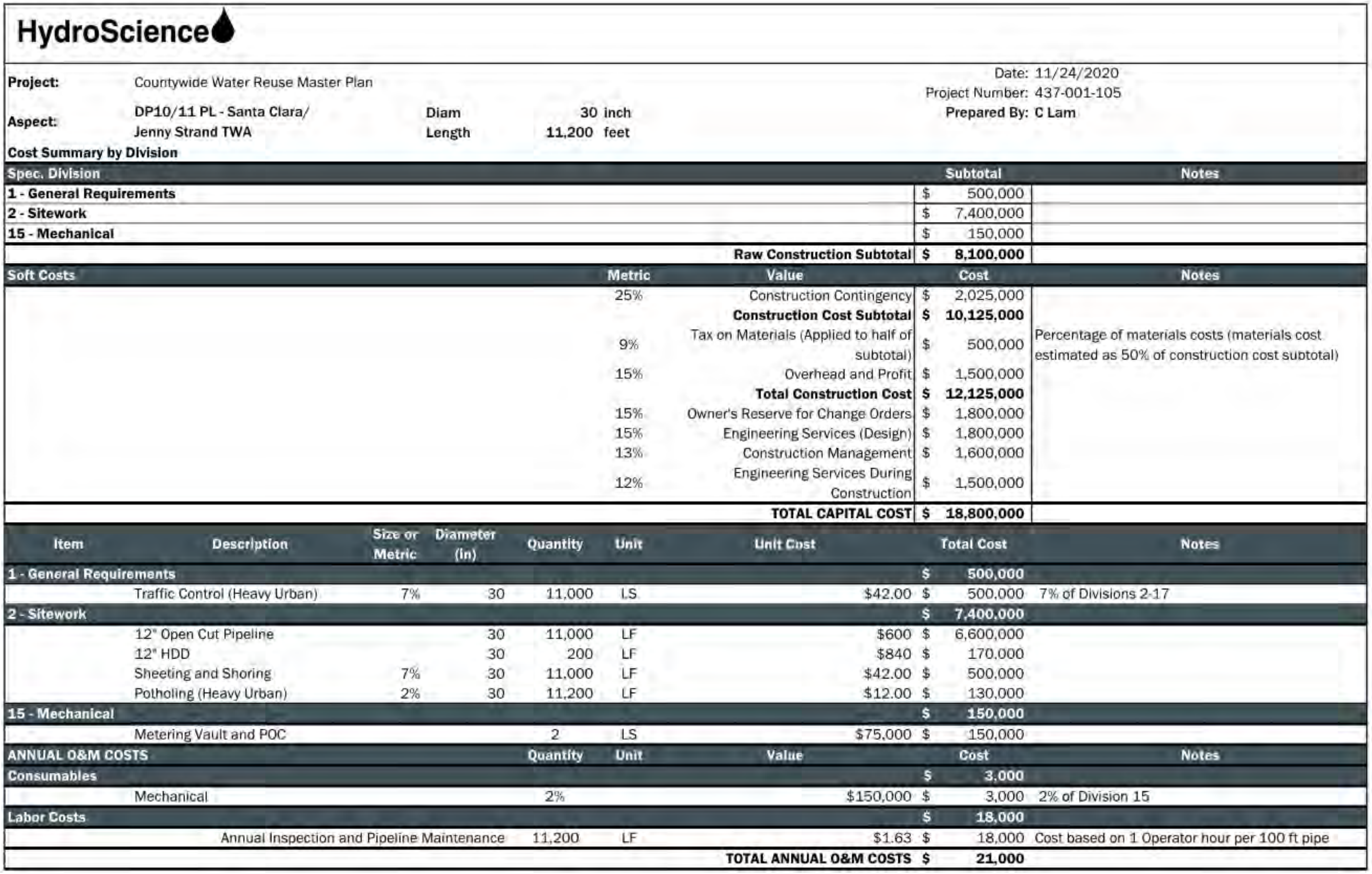
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 100,000	
2 - Sitework		$ 1,910,000	
15 - Mechanical		$ 75,000	
	Raw Construction Subtotal	**$ 2,100,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 525,000	
		Construction Cost Subtotal	**$ 2,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 400,000	
		Total Construction Cost	**$ 3,125,000**	
	15%	Owner's Reserve for Change Orders	$ 500,000	
	15%	Engineering Services (Design)	$ 500,000	
	13%	Construction Management	$ 400,000	
	12%	Engineering Services During Construction	$ 400,000	
		TOTAL CAPITAL COST	**$ 4,900,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 100,000**	
	Traffic Control (Heavy Urban)	7%	12	6,800	LS	$16.80	$ 100,000	7% of Divisions 2-17
2 - Sitework							**$ 1,910,000**	
	12" Open Cut Pipeline		12	6,800	LF	$240	$ 1,600,000	
	12" HDD		12	500	LF	$336	$ 170,000	
	Sheeting and Shoring	7%	12	6,800	LF	$16.80	$ 100,000	
	Potholing (Heavy Urban)	2%	12	7,300	LF	$4.80	$ 40,000	
15 - Mechanical							**$ 75,000**	
	Metering Vault and POC			1	LS	$75,000	$ 75,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 1,500**	
	Mechanical	2%		$75,000	$ 1,500	2% of Division 15
Labor Costs					**$ 12,000**	
	Annual Inspection and Pipeline Maintenance	7,300	LF	$1.63	$ 12,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 13,500**	

Table B-12. Cost Estimate Details for DP10/11 PL (Santa Clara TWA): 30-inch Purified Water Pipeline from GWR Alignment to Santa Clara Jenny Strand Park/ VW Delivery Point



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	11/24/2020
				Project Number:	437-001-105
Aspect:	DP10/11 PL - Santa Clara/ Jenny Strand TWA	Diam	30 inch	**Prepared By:**	**C Lam**
		Length	11,200 feet		

Cost Summary by Division

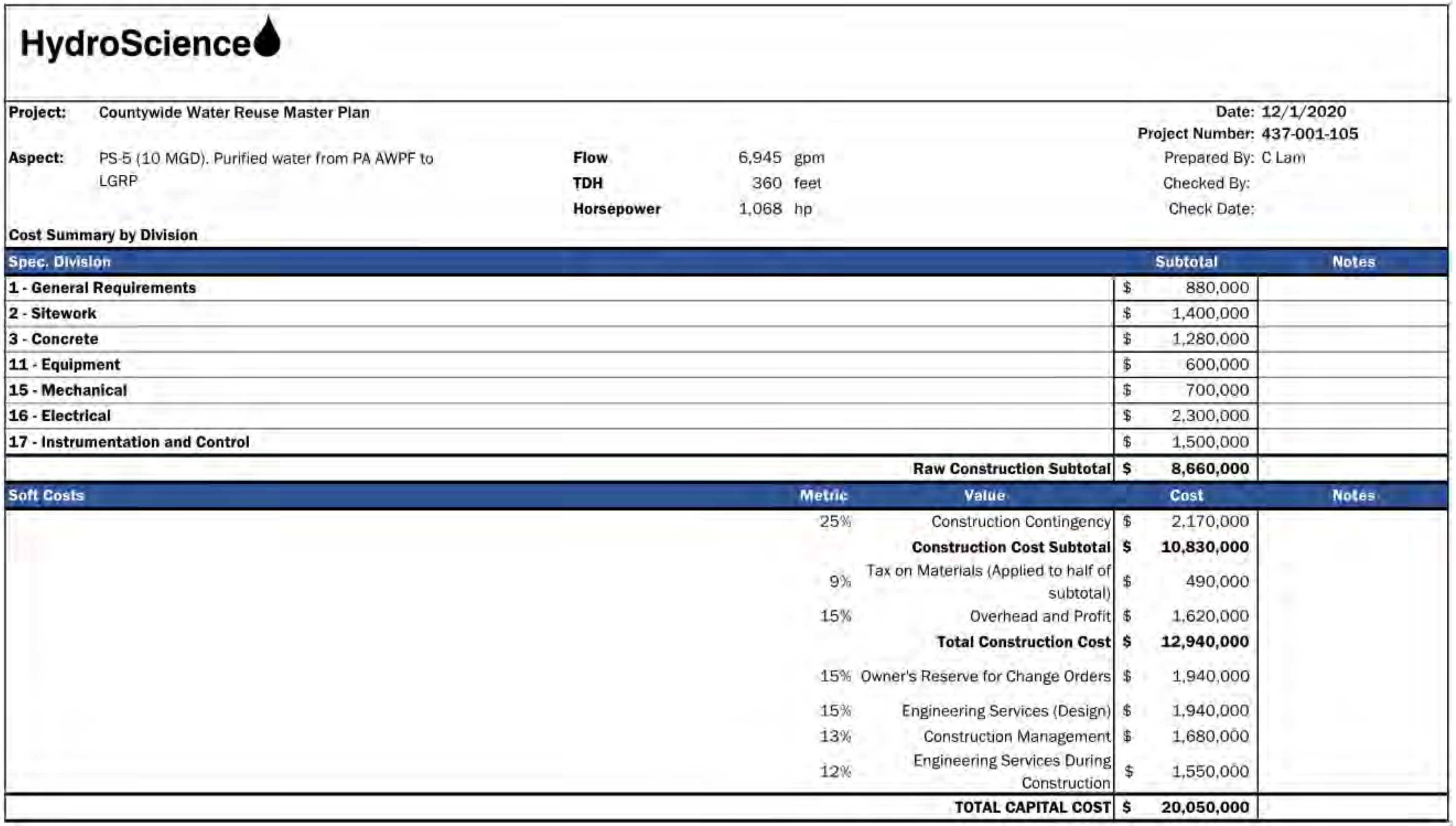
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 500,000	
2 - Sitework	$ 7,400,000	
15 - Mechanical	$ 150,000	
Raw Construction Subtotal	**$ 8,100,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,025,000	
		Construction Cost Subtotal	**$ 10,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 1,500,000	
		Total Construction Cost	**$ 12,125,000**	
	15%	Owner's Reserve for Change Orders	$ 1,800,000	
	15%	Engineering Services (Design)	$ 1,800,000	
	13%	Construction Management	$ 1,600,000	
	12%	Engineering Services During Construction	$ 1,500,000	
		TOTAL CAPITAL COST	**$ 18,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 500,000**	
	Traffic Control (Heavy Urban)	7%	30	11,000	LS	$42.00	$ 500,000	7% of Divisions 2-17
2 - Sitework							**$ 7,400,000**	
	12" Open Cut Pipeline		30	11,000	LF	$600	$ 6,600,000	
	12" HDD		30	200	LF	$840	$ 170,000	
	Sheeting and Shoring	7%	30	11,000	LF	$42.00	$ 500,000	
	Potholing (Heavy Urban)	2%	30	11,200	LF	$12.00	$ 130,000	
15 - Mechanical							**$ 150,000**	
	Metering Vault and POC			2	LS	$75,000	$ 150,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 3,000**	
	Mechanical	2%		$150,000	$ 3,000	2% of Division 15
Labor Costs					**$ 18,000**	
	Annual Inspection and Pipeline Maintenance	11,200	LF	$1.63	$ 18,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 21,000**	

Table B-13. Cost Estimate Details for PS-5: Purified Water Pump Station (up to 10 mgd) from Palo Alto AWPF to LGRP (Near-Term GWR Project)



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-5 (10 MGD). Purified water from PA AWPF to LGRP

Flow 6,945 gpm
TDH 360 feet
Horsepower 1,068 hp

Date: 12/1/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By:
Check Date:

Cost Summary by Division

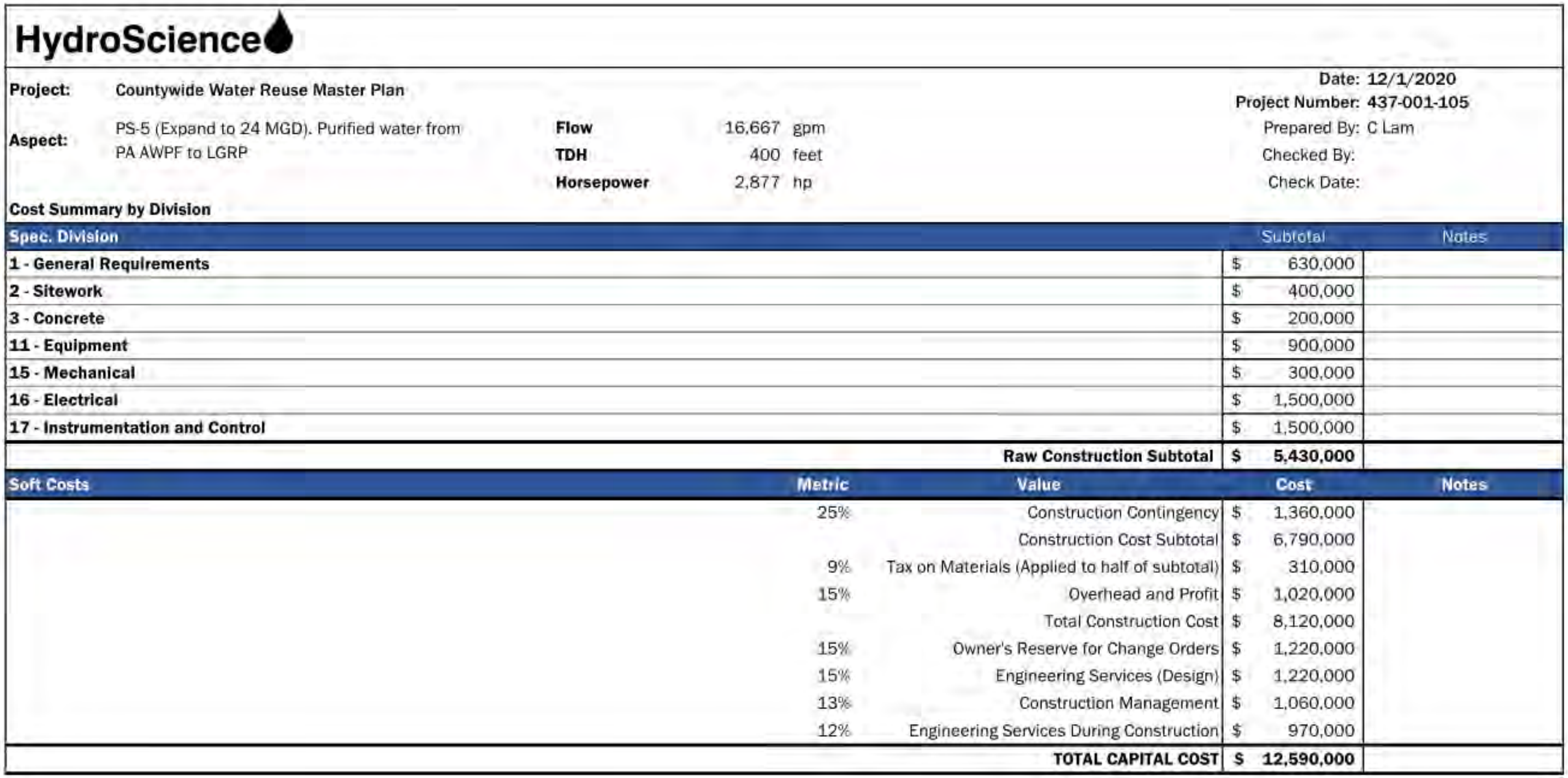
Spec. Division		Subtotal	Notes
1 - General Requirements	$	880,000	
2 - Sitework	$	1,400,000	
3 - Concrete	$	1,280,000	
11 - Equipment	$	600,000	
15 - Mechanical	$	700,000	
16 - Electrical	$	2,300,000	
17 - Instrumentation and Control	$	1,500,000	
Raw Construction Subtotal	**$**	**8,660,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,170,000	
		Construction Cost Subtotal	**$**	**10,830,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	490,000	
	15%	Overhead and Profit	$	1,620,000	
		Total Construction Cost	**$**	**12,940,000**	
	15%	Owner's Reserve for Change Orders	$	1,940,000	
	15%	Engineering Services (Design)	$	1,940,000	
	13%	Construction Management	$	1,680,000	
	12%	Engineering Services During Construction	$	1,550,000	
		TOTAL CAPITAL COST	**$**	**20,050,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 880,000**	
	Mobilization/Demobilization	10%	1	LS		$ 778,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 100,000	
2 - Sitework						**$ 1,400,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 300,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 150,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		**1**	**LS**		**$ 300,000**	
	Landscaping and irrigation		1	LS		$ 100,000	
3 - Concrete						**$ 1,280,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 100,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 600,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 400,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 700,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 500,000	
16 - Electrical						**$ 2,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	

ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 102,000**	
	Equipment		2%		$600,000	$ 12,000	2% of Division 11
	Mechanical		2%		$700,000	$ 14,000	2% of Division 15
	Electrical		2%		$2,300,000	$ 46,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 1,193,000**	
	Electricity Requirement	1,068 hp	6,280,659	kWh	$0.19	$ 1,193,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,295,000**	

Table B-14. Cost Estimate Details for PS-5: Purified Water Pump Station (Flexible Expansion, up to 24 mgd) from Palo Alto AWPF to LGRP (GWR Flex)



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-5 (Expand to 24 MGD). Purified water from PA AWPF to LGRP

Flow 16,667 gpm
TDH 400 feet
Horsepower 2,877 hp

Date: 12/1/2020
Project Number: 437-001-105
Prepared By: C Lam
Checked By:
Check Date:

Cost Summary by Division

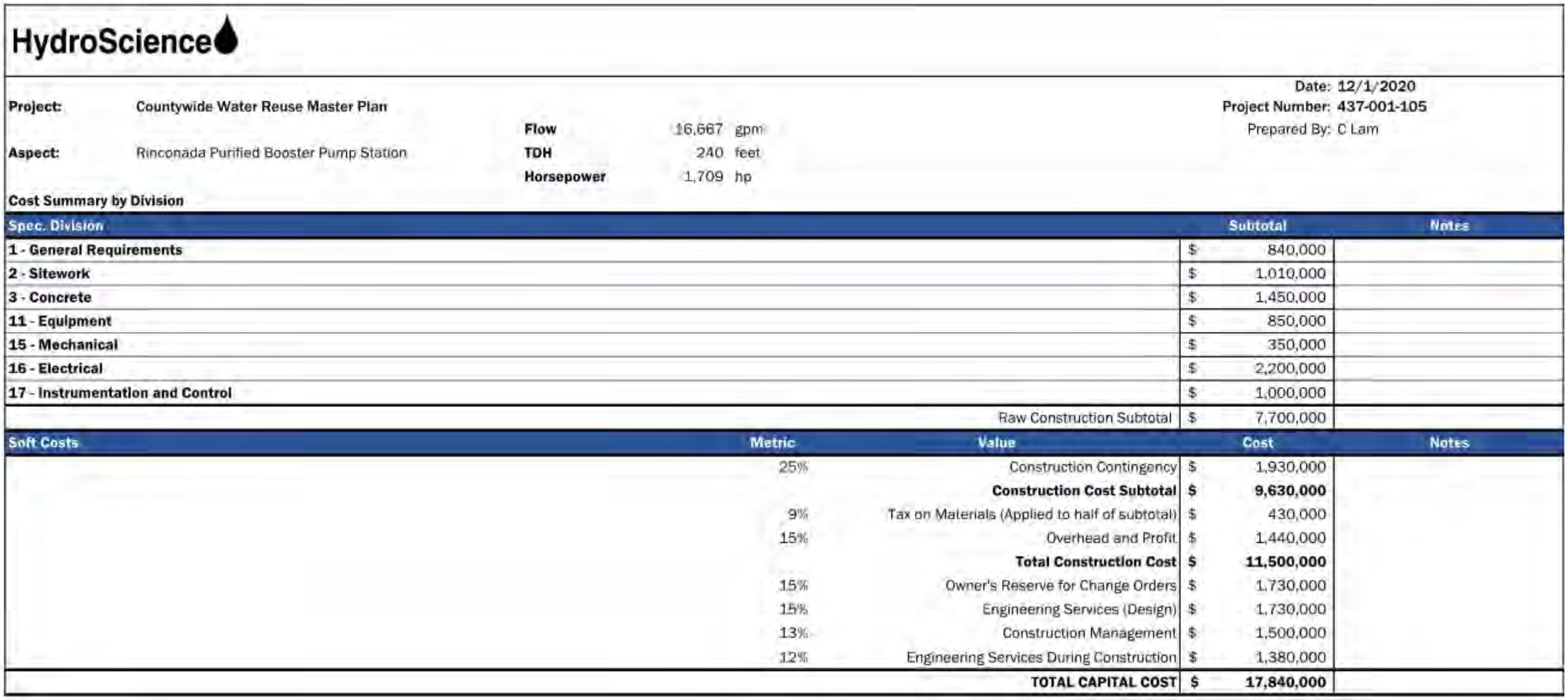
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 630,000	
2 - Sitework	$ 400,000	
3 - Concrete	$ 200,000	
11 - Equipment	$ 900,000	
15 - Mechanical	$ 300,000	
16 - Electrical	$ 1,500,000	
17 - Instrumentation and Control	$ 1,500,000	
Raw Construction Subtotal	**$ 5,430,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 1,360,000	
		Construction Cost Subtotal	$ 6,790,000	
	9%	Tax on Materials (Applied to half of subtotal)	$ 310,000	
	15%	Overhead and Profit	$ 1,020,000	
		Total Construction Cost	$ 8,120,000	
	15%	Owner's Reserve for Change Orders	$ 1,220,000	
	15%	Engineering Services (Design)	$ 1,220,000	
	13%	Construction Management	$ 1,060,000	
	12%	Engineering Services During Construction	$ 970,000	
		TOTAL CAPITAL COST	**$ 12,590,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 630,000**	
	Mobilization/Demobilization	10%	1	LS		$ 480,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						**$ 400,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 100,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 75,000	
	Landscaping and irrigation		1	LS		$ 25,000	
3 - Concrete						**$ 200,000**	
	Equipment slabs	12 inch	1	LS		$ 100,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 100,000	
11 - Equipment						**$ 900,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 300,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 250,000	
16 - Electrical						**$ 1,500,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	

ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 84,000**	
	Equipment		2%		$900,000	$ 18,000	2% of Division 11
	Mechanical		2%		$300,000	$ 6,000	2% of Division 15
	Electrical		2%		$1,500,000	$ 30,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						$ 2,020,000	
	Electricity Requirement (delta from 10 mgd)	1,809 hp	10,630,998	kWh	$0.19	$ 2,020,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,104,000**	

Table B-15. Cost Estimate Details for Rinconada RWA Booster Pump Station: Purified Water from LGRP to Rinconada WTP (RWA Flex)



HydroScience

Date: 12/1/2020
Project Number: 437-001-105
Prepared By: C Lam

Project: Countywide Water Reuse Master Plan

Aspect: Rinconada Purified Booster Pump Station

Flow 16,667 gpm
TDH 240 feet
Horsepower 1,709 hp

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	840,000	
2 - Sitework	$	1,010,000	
3 - Concrete	$	1,450,000	
11 - Equipment	$	850,000	
15 - Mechanical	$	350,000	
16 - Electrical	$	2,200,000	
17 - Instrumentation and Control	$	1,000,000	
Raw Construction Subtotal	$	7,700,000	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	1,930,000	
		Construction Cost Subtotal	**$**	**9,630,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	430,000	
	15%	Overhead and Profit	$	1,440,000	
		Total Construction Cost	**$**	**11,500,000**	
	15%	Owner's Reserve for Change Orders	$	1,730,000	
	15%	Engineering Services (Design)	$	1,730,000	
	13%	Construction Management	$	1,500,000	
	12%	Engineering Services During Construction	$	1,380,000	
		TOTAL CAPITAL COST	**$**	**17,840,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 840,000**	
	Mobilization/Demobilization	10%	1	LS		$ 686,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 150,000	
2 - Sitework						**$ 1,010,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 250,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 60,000	
	Asphalt Paving		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 200,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 125,000	
	Landscaping and irrigation		1	LS		$ 25,000	
3 - Concrete						**$ 1,450,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Equipment slabs	12 inch	1	LS		$ 200,000	
	Building slabs	18 inch	1	LS		$ 250,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 100,000	
	CMU Building	25 X 40 foot	1	LS		$ 800,000	+HVAC, finishes, aesthetics
11 - Equipment						**$ 850,000**	
	Centrifugal Pumps		1	LS		$ 750,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 350,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 100,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 250,000	
16 - Electrical						**$ 2,200,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,600,000	
	Standby generator		1	LS		$ 600,000	
17 - I&C						**$ 1,000,000**	
	I&C/SCADA/Programming Allowance					$ 1,000,000	

ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 88,000**	
	Equipment		2%		$850,000	$ 17,000	2% of Division 11
	Mechanical		2%		$350,000	$ 7,000	2% of Division 15
	Electrical		2%		$2,200,000	$ 44,000	2% of Division 16
	Instrumentation		2%		$1,000,000	$ 20,000	2% of Division 17
Power Costs						**$ 1,909,000**	
	Electricity Requirement	1,709 hp	10,048,451	kWh	$0.19	$ 1,909,000	50% utilization assumed
					TOTAL ANNUAL O&M COSTS	**$ 1,997,000**	

Table B-16. Lifecycle Unit Costs for Palo Alto 10 mgd Flex Near-Term GWR Project

Palo Alto Near Term 10 mgd

Summary of Lifecycle Unit Costs ($/AF)								
Time Horizon	Unit Costs, excluding ROC management		Unit Costs, excluding R&R and ROC management		ROCM Unit Costs Only		Unit Costs, including ROC management	
	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Low Estimate (Upper Bound Yield)	High Estimate (Lower Bound Yield)	Lowest Cost Option Estimate	Highest Cost Option Estimate	Low Estimate	High Estimate
100-Yr Lifecycle:	$ 2,500	$ 2,500	$ 2,100	$ 2,100	$ 200	200	$ 2,700	$ 2,700
30-Yr Lifecycle:	$ 3,400	$ 3,400	$ 3,100	$ 3,100	$ 200	200	$ 3,600	$ 3,600

[1] ROC management costs included for context only. The estimated ROC management lifecycle costs are based on Portfolio 1 as calculated in Task 6 - Evaluation of ROC Management Options Final Report (GHD 2020), deescalated from Jan 2020 $ to Jul 2019 $ using the ENR Construction Cost Index for San Francisco. The flexible implementation scenarios assume that the ROC management strategy will be implemented in the near term with sufficient capacity to manage ROC from a 24 mgd plant. Although ROC management capital costs for the near term would be the same as in Portfolio 1, the O&M costs would be lower due to lower volumes of ROC, lowering the actual lifecycle cost for ROC management.

Lifecycle Cost Calculations, excluding ROC management										
Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
	100-Yr Lifecycle:	**$485,000,000**	**$940,000,000**	**$685,000,000**	**$2,110,000,000**	**$840,000,000**	**1,100,000**	**340,000**	**1,100,000**	**340,000**
	30-Yr Lifecycle:	**$485,000,000**	**$285,000,000**	**$115,000,000**	**$885,000,000**	**$635,000,000**	**330,000**	**192,000**	**330,000**	**192,000**
2019				$0	$0	$0				
2020				$0	$0	$0				
2021				$0	$0	$0				
2022				$0	$0	$0				
2023				$0	$0	$0				
2024		$121,250,000		$0	$121,250,000	$107,548,801				
2025		$121,250,000		$0	$121,250,000	$105,000,251				
2026		$121,250,000		$0	$121,250,000	$102,512,094				
2027		$121,250,000		$0	$121,250,000	$100,082,897				
2028	Year 1		$9,400,000	$0	$9,400,000	$7,575,141	11,000	8,865	11,000	8,865
2029	Year 2		$9,400,000	$0	$9,400,000	$7,395,636	11,000	8,654	11,000	8,654
2030	Year 3		$9,400,000	$0	$9,400,000	$7,220,384	11,000	8,449	11,000	8,449
2031	Year 4		$9,400,000	$0	$9,400,000	$7,049,284	11,000	8,249	11,000	8,249
2032	Year 5		$9,400,000	$0	$9,400,000	$6,882,240	11,000	8,054	11,000	8,054
2033	Year 6		$9,400,000	$0	$9,400,000	$6,719,154	11,000	7,863	11,000	7,863
2034	Year 7		$9,400,000	$0	$9,400,000	$6,559,932	11,000	7,677	11,000	7,677
2035	Year 8		$9,400,000	$204,002	$9,604,002	$6,543,476	11,000	7,495	11,000	7,495
2036	Year 9		$9,400,000	$0	$9,400,000	$6,252,718	11,000	7,317	11,000	7,317
2037	Year 10		$9,400,000	$2,207,788	$11,607,788	$7,538,332	11,000	7,144	11,000	7,144
2038	Year 11		$9,400,000	$0	$9,400,000	$5,959,892	11,000	6,974	11,000	6,974
2039	Year 12		$9,400,000	$0	$9,400,000	$5,818,662	11,000	6,809	11,000	6,809
2040	Year 13		$9,400,000	$0	$9,400,000	$5,680,779	11,000	6,648	11,000	6,648
2041	Year 14		$9,400,000	$0	$9,400,000	$5,546,164	11,000	6,490	11,000	6,490
2042	Year 15		$9,400,000	$733,568	$10,133,568	$5,837,300	11,000	6,336	11,000	6,336

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2043	Year 16		$9,400,000	$204,002	$9,604,002	$5,401,155	11,000	6,186	11,000	6,186
2044	Year 17		$9,400,000	$0	$9,400,000	$5,161,156	11,000	6,040	11,000	6,040
2045	Year 18		$9,400,000	$0	$9,400,000	$5,038,854	11,000	5,897	11,000	5,897
2046	Year 19		$9,400,000	$0	$9,400,000	$4,919,450	11,000	5,757	11,000	5,757
2047	Year 20		$9,400,000	$18,839,358	$28,239,358	$14,428,734	11,000	5,620	11,000	5,620
2048	Year 21		$9,400,000	$0	$9,400,000	$4,689,063	11,000	5,487	11,000	5,487
2049	Year 22		$9,400,000	$0	$9,400,000	$4,577,947	11,000	5,357	11,000	5,357
2050	Year 23		$9,400,000	$0	$9,400,000	$4,469,465	11,000	5,230	11,000	5,230
2051	Year 24		$9,400,000	$204,002	$9,604,002	$4,458,253	11,000	5,106	11,000	5,106
2052	Year 25		$9,400,000	$84,299,858	$93,699,858	$42,465,494	11,000	4,985	11,000	4,985
2053	Year 26		$9,400,000	$0	$9,400,000	$4,159,201	11,000	4,867	11,000	4,867
2054	Year 27		$9,400,000	$0	$9,400,000	$4,060,641	11,000	4,752	11,000	4,752
2055	Year 28		$9,400,000	$0	$9,400,000	$3,964,418	11,000	4,639	11,000	4,639
2056	Year 29		$9,400,000	$0	$9,400,000	$3,870,474	11,000	4,529	11,000	4,529
2057	Year 30		$9,400,000	$6,532,086	$15,932,086	$6,404,625	11,000	4,422	11,000	4,422
2058	Year 31		$9,400,000	$0	$9,400,000	$3,689,213	11,000	4,317	11,000	4,317
2059	Year 32		$9,400,000	$12,989	$9,412,989	$3,606,768	11,000	4,215	11,000	4,215
2060	Year 33		$9,400,000	$191,013	$9,591,013	$3,587,896	11,000	4,115	11,000	4,115
2061	Year 34		$9,400,000	$0	$9,400,000	$3,433,112	11,000	4,017	11,000	4,017
2062	Year 35		$9,400,000	$0	$9,400,000	$3,351,759	11,000	3,922	11,000	3,922
2063	Year 36		$9,400,000	$0	$9,400,000	$3,272,333	11,000	3,829	11,000	3,829
2064	Year 37		$9,400,000	$0	$9,400,000	$3,194,790	11,000	3,739	11,000	3,739
2065	Year 38		$9,400,000	$0	$9,400,000	$3,119,084	11,000	3,650	11,000	3,650
2066	Year 39		$9,400,000	$0	$9,400,000	$3,045,172	11,000	3,563	11,000	3,563
2067	Year 40		$9,400,000	$20,508,356	$29,908,356	$9,459,349	11,000	3,479	11,000	3,479
2068	Year 41		$9,400,000	$191,013	$9,591,013	$2,961,542	11,000	3,397	11,000	3,397
2069	Year 42		$9,400,000	$0	$9,400,000	$2,833,780	11,000	3,316	11,000	3,316
2070	Year 43		$9,400,000	$0	$9,400,000	$2,766,629	11,000	3,238	11,000	3,238
2071	Year 44		$9,400,000	$0	$9,400,000	$2,701,069	11,000	3,161	11,000	3,161
2072	Year 45		$9,400,000	$733,568	$10,133,568	$2,842,856	11,000	3,086	11,000	3,086
2073	Year 46		$9,400,000	$0	$9,400,000	$2,574,573	11,000	3,013	11,000	3,013
2074	Year 47		$9,400,000	$0	$9,400,000	$2,513,564	11,000	2,941	11,000	2,941
2075	Year 48		$9,400,000	$12,989	$9,412,989	$2,457,392	11,000	2,872	11,000	2,872
2076	Year 49		$9,400,000	$191,013	$9,591,013	$2,444,534	11,000	2,804	11,000	2,804
2077	Year 50		$9,400,000	$103,470,645	$112,870,645	$28,086,484	11,000	2,737	11,000	2,737
2078	Year 51		$9,400,000	$0	$9,400,000	$2,283,647	11,000	2,672	11,000	2,672
2079	Year 52		$9,400,000	$0	$9,400,000	$2,229,532	11,000	2,609	11,000	2,609
2080	Year 53		$9,400,000	$0	$9,400,000	$2,176,700	11,000	2,547	11,000	2,547
2081	Year 54		$9,400,000	$0	$9,400,000	$2,125,119	11,000	2,487	11,000	2,487
2082	Year 55		$9,400,000	$0	$9,400,000	$2,074,761	11,000	2,428	11,000	2,428
2083	Year 56		$9,400,000	$12,989	$9,412,989	$2,028,395	11,000	2,370	11,000	2,370
2084	Year 57		$9,400,000	$0	$9,400,000	$1,977,596	11,000	2,314	11,000	2,314
2085	Year 58		$9,400,000	$191,013	$9,591,013	$1,969,967	11,000	2,259	11,000	2,259
2086	Year 59		$9,400,000	$0	$9,400,000	$1,884,982	11,000	2,206	11,000	2,206

Year	Operations Year #	Estimated Costs, excluding ROC management (August 2019 Dollars)				Present Value Cost in 2019, excluding ROC management	Average Water Supply System Yield, Upper Bound (AF)	Present Value Yield in 2019, Upper Bound (AF)	Average Water Supply System Yield, Lower Bound (AF)	Present Value Yield in 2019, Lower Bound (AF)
		Capital Cost	O&M Cost	R&R	Total Cost					
2087	Year 60		$9,400,000	$22,852,889	$32,252,889	$6,314,408	11,000	2,154	11,000	2,154
2088	Year 61		$9,400,000	$5,179	$9,405,179	$1,797,694	11,000	2,103	11,000	2,103
2089	Year 62		$9,400,000	$7,610	$9,407,610	$1,755,549	11,000	2,053	11,000	2,053
2090	Year 63		$9,400,000	$11,073	$9,411,073	$1,714,579	11,000	2,004	11,000	2,004
2091	Year 64		$9,400,000	$28,940	$9,428,940	$1,677,127	11,000	1,957	11,000	1,957
2092	Year 65		$9,400,000	$22,749	$9,422,749	$1,636,310	11,000	1,910	11,000	1,910
2093	Year 66		$9,400,000	$223,135	$9,623,135	$1,631,508	11,000	1,865	11,000	1,865
2094	Year 67		$9,400,000	$44,903	$9,444,903	$1,563,345	11,000	1,821	11,000	1,821
2095	Year 68		$9,400,000	$62,149	$9,462,149	$1,529,086	11,000	1,778	11,000	1,778
2096	Year 69		$9,400,000	$85,157	$9,485,157	$1,496,482	11,000	1,735	11,000	1,735
2097	Year 70		$9,400,000	$3,541,445	$12,941,445	$1,993,400	11,000	1,694	11,000	1,694
2098	Year 71		$9,400,000	$155,166	$9,555,166	$1,436,927	11,000	1,654	11,000	1,654
2099	Year 72		$9,400,000	$219,323	$9,619,323	$1,412,296	11,000	1,615	11,000	1,615
2100	Year 73		$9,400,000	$271,646	$9,671,646	$1,386,329	11,000	1,577	11,000	1,577
2101	Year 74		$9,400,000	$545,085	$9,945,085	$1,391,744	11,000	1,539	11,000	1,539
2102	Year 75		$9,400,000	$124,340,788	$133,740,788	$18,272,559	11,000	1,503	11,000	1,503
2103	Year 76		$9,400,000	$583,765	$9,983,765	$1,331,725	11,000	1,467	11,000	1,467
2104	Year 77		$9,400,000	$738,409	$10,138,409	$1,320,307	11,000	1,433	11,000	1,433
2105	Year 78		$9,400,000	$924,727	$10,324,727	$1,312,709	11,000	1,399	11,000	1,399
2106	Year 79		$9,400,000	$1,146,533	$10,546,533	$1,309,134	11,000	1,365	11,000	1,365
2107	Year 80		$9,400,000	$21,601,499	$31,001,499	$3,757,007	11,000	1,333	11,000	1,333
2108	Year 81		$9,400,000	$1,710,427	$11,110,427	$1,314,543	11,000	1,301	11,000	1,301
2109	Year 82		$9,400,000	$2,058,019	$11,458,019	$1,323,544	11,000	1,271	11,000	1,271
2110	Year 83		$9,400,000	$2,642,618	$12,042,618	$1,358,109	11,000	1,241	11,000	1,241
2111	Year 84		$9,400,000	$2,891,408	$12,291,408	$1,353,318	11,000	1,211	11,000	1,211
2112	Year 85		$9,400,000	$3,376,174	$12,776,174	$1,373,359	11,000	1,182	11,000	1,182
2113	Year 86		$9,400,000	$3,902,992	$13,302,992	$1,396,102	11,000	1,154	11,000	1,154
2114	Year 87		$9,400,000	$4,467,116	$13,867,116	$1,420,819	11,000	1,127	11,000	1,127
2115	Year 88		$9,400,000	$5,074,896	$14,474,896	$1,447,948	11,000	1,100	11,000	1,100
2116	Year 89		$9,400,000	$5,678,820	$15,078,820	$1,472,616	11,000	1,074	11,000	1,074
2117	Year 90		$9,400,000	$12,310,669	$21,710,669	$2,070,047	11,000	1,049	11,000	1,049
2118	Year 91		$9,400,000	$7,127,139	$16,527,139	$1,538,471	11,000	1,024	11,000	1,024
2119	Year 92		$9,400,000	$7,551,478	$16,951,478	$1,540,579	11,000	1,000	11,000	1,000
2120	Year 93		$9,400,000	$8,139,619	$17,539,619	$1,556,257	11,000	976	11,000	976
2121	Year 94		$9,400,000	$8,686,270	$18,086,270	$1,566,733	11,000	953	11,000	953
2122	Year 95		$9,400,000	$9,177,395	$18,577,395	$1,571,143	11,000	930	11,000	930
2123	Year 96		$9,400,000	$9,612,801	$19,012,801	$1,569,863	11,000	908	11,000	908
2124	Year 97		$9,400,000	$9,941,754	$19,341,754	$1,559,180	11,000	887	11,000	887
2125	Year 98		$9,400,000	$10,193,430	$19,593,430	$1,542,040	11,000	866	11,000	866
2126	Year 99		$9,400,000	$10,538,498	$19,938,498	$1,532,012	11,000	845	11,000	845
2127	Year 100		$9,400,000	$141,614,697	$151,014,697	$11,328,537	11,000	825	11,000	825

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Attachment C: Palo Alto Pipeline Sizing Cost Analysis

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Table C-1. Overview of Costs for Various Palo Alto Pipeline Diameter Options

										Conveyance Costs			
Reference: CoRe Plan, App. A-6	Reference: CoRe Plan, App A-11, Att. C	ID no.	Project element	Location or start point	End point	**Diameter (in)**	Horse-power (hp)	Length (LF)	Length (miles)	Capital	Annual O&M	Rounded Capital	Rounded Annual O&M
Modified Portfolio 2a: Conveyance for 24 mgd between PA AWPF and LGRP, with future capacity for other sources (up to 40 mgd)													
	Table C-2	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	–	15,150	2.9	$ 29	$ 0.03	$ 445	$ 5.1
	Table C-3	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	–	38,820	7.4	$ 74	$ 0.06		
	Table C-4	PL-7 48-in	Purified Water Pipeline	Palo Alto AWPF	LGRP	**48**		107,400	20.3	$ 284	$ 0.2		
	Table C-9	PS-3	Pump Station (17.3 mgd)	Palo Alto RWQCP	Palo Alto AWPF	–	508	–	–	$ 4	$ 0.6		
	Table C-10	PS-4	Pump Station (11.5 mgd)	Sunnyvale WPCP	Palo Alto AWPF	–	400	–	–	$ 4	$ 0.4		
	Table C-12	PS-5_24 mgd	Pump Station (24 mgd)	Palo Alto AWPF	LGRP	–	2,877	–	–	$ 28	$ 3.4		
Table 29		LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	$ 15	$ 0.4		
		PL Easements	Easement[a]	–	–	–	–	161,370	30.6	$ 5	$ -		
TOTAL												**$ 445**	**$ 5.1**
Modified Portfolio 2a: Conveyance for up to 24 mgd between PA AWPF and LGRP													
	Table C-2	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	–	15,150	2.9	$ 29	$ 0.03	$ 375	$ 5.1
	Table C-3	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	–	38,820	7.4	$ 74	$ 0.06		
	Table C-5	PL-7 36-in	Purified Water Pipeline	Palo Alto AWPF	LGRP	**36**		107,400	20.3	$ 213	$ 0.2		
	Table C-9	PS-3	Pump Station (17.3 mgd)	Palo Alto RWQCP	Palo Alto AWPF	–	508	–	–	$ 4	$ 0.6		
	Table C-10	PS-4	Pump Station (11.5 mgd)	Sunnyvale WPCP	Palo Alto AWPF	–	400	–	–	$ 4	$ 0.4		
	Table C-12	PS-5_24 mgd	Pump Station (24 mgd)	Palo Alto AWPF	LGRP	–	2,877	–	–	$ 28	$ 3.4		
Table 29		LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	$ 15	$ 0.4		
		PL Easements	Easement[a]	–	–	–	–	161,370	30.6	$ 5	$ -		
TOTAL												**$ 375**	**$ 5.1**
Modified Portfolio 2a: Conveyance for up to 24 mgd between PA AWPF and LGRP, with 14 mgd for TWA and 10 mgd for GWR													
	Table C-2	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	–	15,150	2.9	$ 29	$ 0.03	$ 355	$ 5.2
	Table C-3	PL-6	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	36	–	38,820	7.4	$ 74	$ 0.06		
	Table C-8	PL-7 36-in (Mod)	Purified Water Pipeline	Palo Alto AWPF	Pruneridge Ave	**36**		72,870	13.8	$ 144	$ 0.2		
	Table C-7	PL-7 24-in (Mod)	Purified Water Pipeline	Pruneridge Ave	LGRP	**24**		34,530	6.5	$ 46	$ 0.2		
	Table C-9	PS-3	Pump Station (17.3 mgd)	Palo Alto RWQCP	Palo Alto AWPF	–	508	–	–	$ 4	$ 0.6		
	Table C-10	PS-4	Pump Station (11.5 mgd)	Sunnyvale WPCP	Palo Alto AWPF	–	400	–	–	$ 4	$ 0.4		
	Table C-12	PS-5_24 mgd	Pump Station (24 mgd)	Palo Alto AWPF	LGRP	–	2,877	–	–	$ 28	$ 3.4		
Table 29		LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	$ 15	$ 0.4		
		PL Easements	Easement[a]	–	–	–	–	161,370	30.6	$ 5	$ -		
TOTAL												**$ 355**	**$ 5.2**
Modified Portfolio 2a: Conveyance for up to 16 mgd between PA AWPF and LGRP													
	Table C-13	PL-5 (12 mgd)	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	30	–	15,150	2.9	$ 25	$ 0.03	$ 305	$ 3.6
	Table C-14	PL-6 (8 mgd)	Effluent Pipeline	Sunnyvale WPCP	Palo Alto AWPF	24	–	38,820	7.4	$ 50	$ 0.06		
	Table C-15	PL-7 (16 mgd)	Purified Water Pipeline	Palo Alto AWPF	LGRP	**30**		107,400	20.3	$ 178	$ 0.2		
	Table C-16	PS-3 (12 mgd)	Pump Station	Palo Alto RWQCP	Palo Alto AWPF	–	356	–	–	$ 4	$ 0.4		
	Table C-17	PS-4 (8 mgd)	Pump Station	Sunnyvale WPCP	Palo Alto AWPF	–	237	–	–	$ 4	$ 0.2		
	Table C-18	PS-5 (16 mgd)	Pump Station	Palo Alto AWPF	LGRP	–	1,899	–	–	$ 21	$ 2.2		
Table 29		LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	$ 15	$ 0.4		
		PL Easements	Easement[a]	–	–	–	–	161,370	30.6	$ 5	$ -		
TOTAL												**$ 305**	**$ 3.6**
Modified Portfolio 2a: Conveyance for up to 10 mgd between PA AWPF and LGRP													
	Table C-2	PL-5	Effluent Pipeline	Palo Alto RWQCP	Palo Alto AWPF	36	–	15,150	2.9	$ 29	$ 0.03	$ 215	$ 2.5
	Table C-6	PL-7 24-in	Purified Water Pipeline	Palo Alto AWPF	LGRP	**24**		107,400	20.3	$ 142	$ 0.2		
	Table C-9	PS-3	Pump Station (17.3 mgd)	Palo Alto RWQCP	Palo Alto AWPF	–	508	–	–	$ 4	$ 0.6		
	Table C-11	PS-5_10	Pump Station (10 mgd)	Palo Alto AWPF	LGRP	–	1,068	–	–	$ 20	$ 1.3		
Table 29		LGRP-1	LGRP Site Improvements	–	–	–	–	–	–	$ 15	$ 0.4		
		PL Easements	Easement[a]	–	–	–	–	122,550	23.2	$ 4	$ -		
TOTAL												**$ 215**	**$ 2.5**

a. Assumes that pipeline easement cost is $32/foot.

b. All costs reported in July 2019 dollars.

Table C-2. Cost Estimate Details: PL-5, 36-inch Effluent Pipeline from Palo Alto RWQCP to Palo Alto AWPF

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/4/2021
				Project Number:	437-001-105
Aspect:	PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF	**Diam**	36 inch	Prepared By:	N. Venugopal
		Length	15,150 feet	Checked By:	C Lam

Estimate Type: Planning

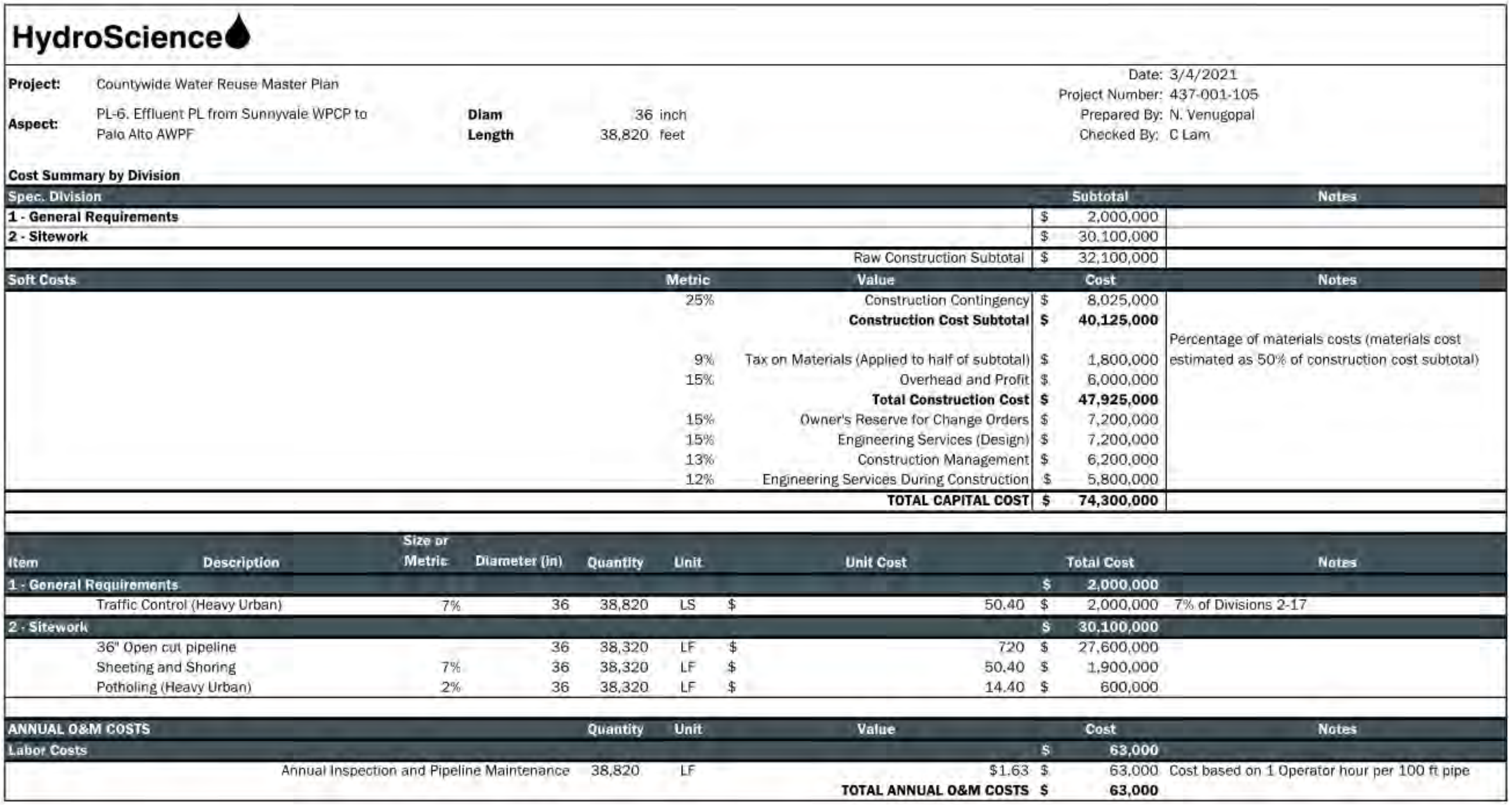
Cost Summary by Division

Spec. Division	Metric	Value		Subtotal	Notes
1 - General Requirements			$	700,000	
2 - Sitework			$	12,000,000	
		Raw Construction Subtotal	$	12,700,000	
Soft Costs	**Metric**	**Value**		**Cost**	**Notes**
	25%	Construction Contingency	$	3,175,000	
		Construction Cost Subtotal	**$**	**15,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	700,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	2,400,000	
		Total Construction Cost	**$**	**18,975,000**	
	15%	Owner's Reserve for Change Orders	$	2,800,000	
	15%	Engineering Services (Design)	$	2,800,000	
	13%	Construction Management	$	2,500,000	
	12%	Engineering Services During Construction	$	2,300,000	
		TOTAL CAPITAL COST	**$**	**29,400,000**	

Item	Description	Size or Metric	Diameter (In)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 700,000**	
	Traffic Control (Heavy Urban)	7%	36	14,500	LS	$ 50.40	$ 700,000	7% of Divisions 2-17
2 - Sitework							**$ 12,000,000**	
	36" Open cut pipeline		36	14,500	LF	$ 720	$ 10,400,000	
	36" HDD Pipeline		36	650	LF	$ 1,008	$ 700,000	
	Sheeting and Shoring	7%	36	14,500	LF	$ 50.40	$ 700,000	
	Potholing (Heavy Urban)	2%	36	15,150	LF	$ 14.40	$ 200,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					**$ 25,000**	
	Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$ 25,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 25,000**	

Table C-3. Cost Estimate Details: PL-6, 36-inch Effluent Pipeline from Sunnyvale WPCP to Palo Alto AWPF



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/4/2021
				Project Number:	437-001-105
Aspect:	PL-6. Effluent PL from Sunnyvale WPCP to Palo Alto AWPF	**Diam**	36 inch	Prepared By:	N. Venugopal
		Length	38,820 feet	Checked By:	C Lam

Cost Summary by Division

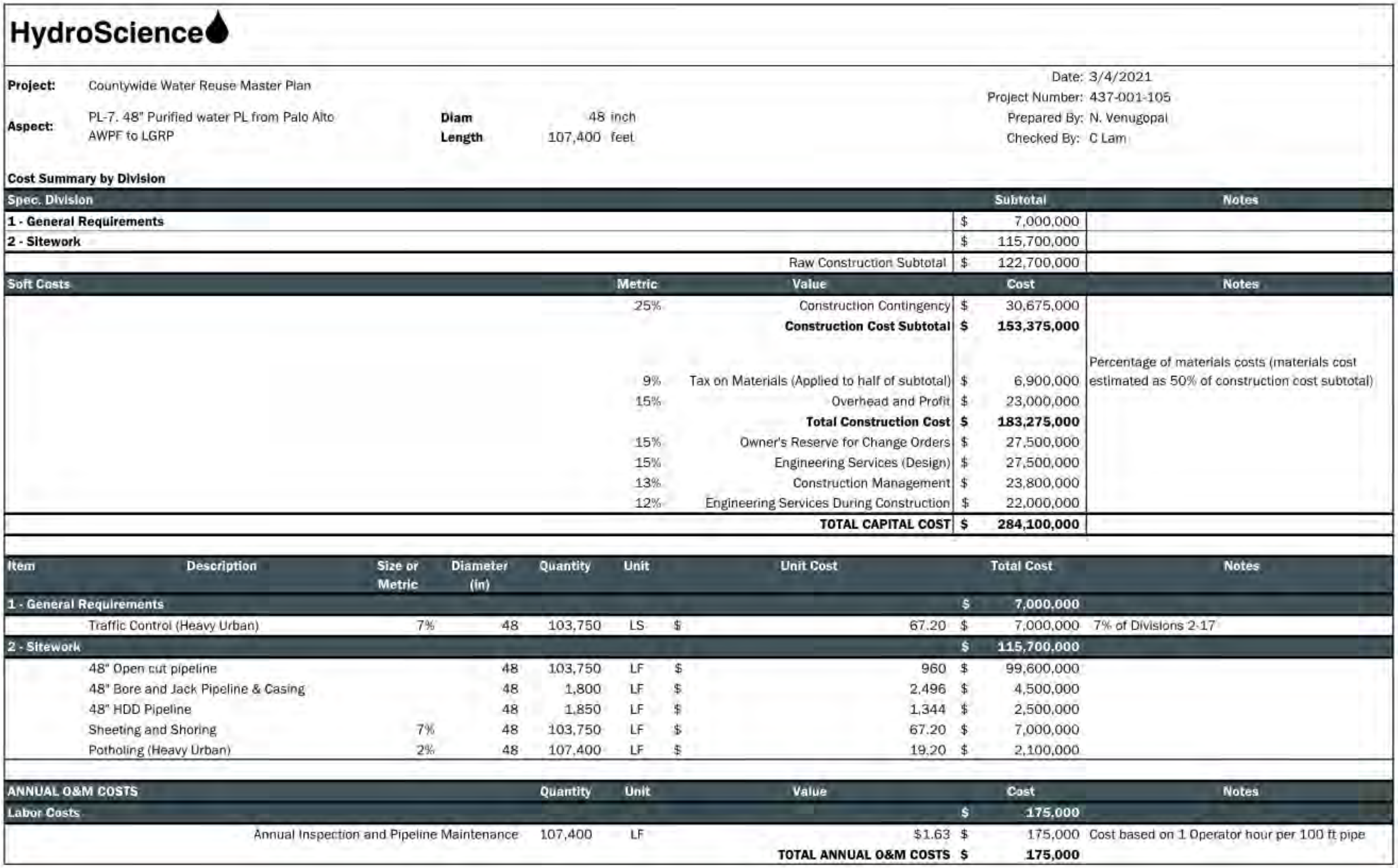
Spec. Division			Subtotal	Notes
1 - General Requirements		$	2,000,000	
2 - Sitework		$	30,100,000	
	Raw Construction Subtotal	$	32,100,000	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	8,025,000	
		Construction Cost Subtotal	**$**	**40,125,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	1,800,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$	6,000,000	
		Total Construction Cost	**$**	**47,925,000**	
	15%	Owner's Reserve for Change Orders	$	7,200,000	
	15%	Engineering Services (Design)	$	7,200,000	
	13%	Construction Management	$	6,200,000	
	12%	Engineering Services During Construction	$	5,800,000	
		TOTAL CAPITAL COST	**$**	**74,300,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements							$	2,000,000	
	Traffic Control (Heavy Urban)	7%	36	38,820	LS	$ 50.40	$	2,000,000	7% of Divisions 2-17
2 - Sitework							$	30,100,000	
	36" Open cut pipeline		36	38,320	LF	$ 720	$	27,600,000	
	Sheeting and Shoring	7%	36	38,320	LF	$ 50.40	$	1,900,000	
	Potholing (Heavy Urban)	2%	36	38,320	LF	$ 14.40	$	600,000	

ANNUAL O&M COSTS	Quantity	Unit	Value		Cost	Notes
Labor Costs				$	63,000	
Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$	63,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$**	**63,000**	

Table C-4. Cost Estimate Details: PL-7, 48-inch Purified Water Pipeline from Palo Alto AWPF to LGRP



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/4/2021
				Project Number:	437-001-105
Aspect:	PL-7. 48" Purified water PL from Palo Alto AWPF to LGRP	**Diam**	48 inch	Prepared By:	N. Venugopal
		Length	107,400 feet	Checked By:	C Lam

Cost Summary by Division

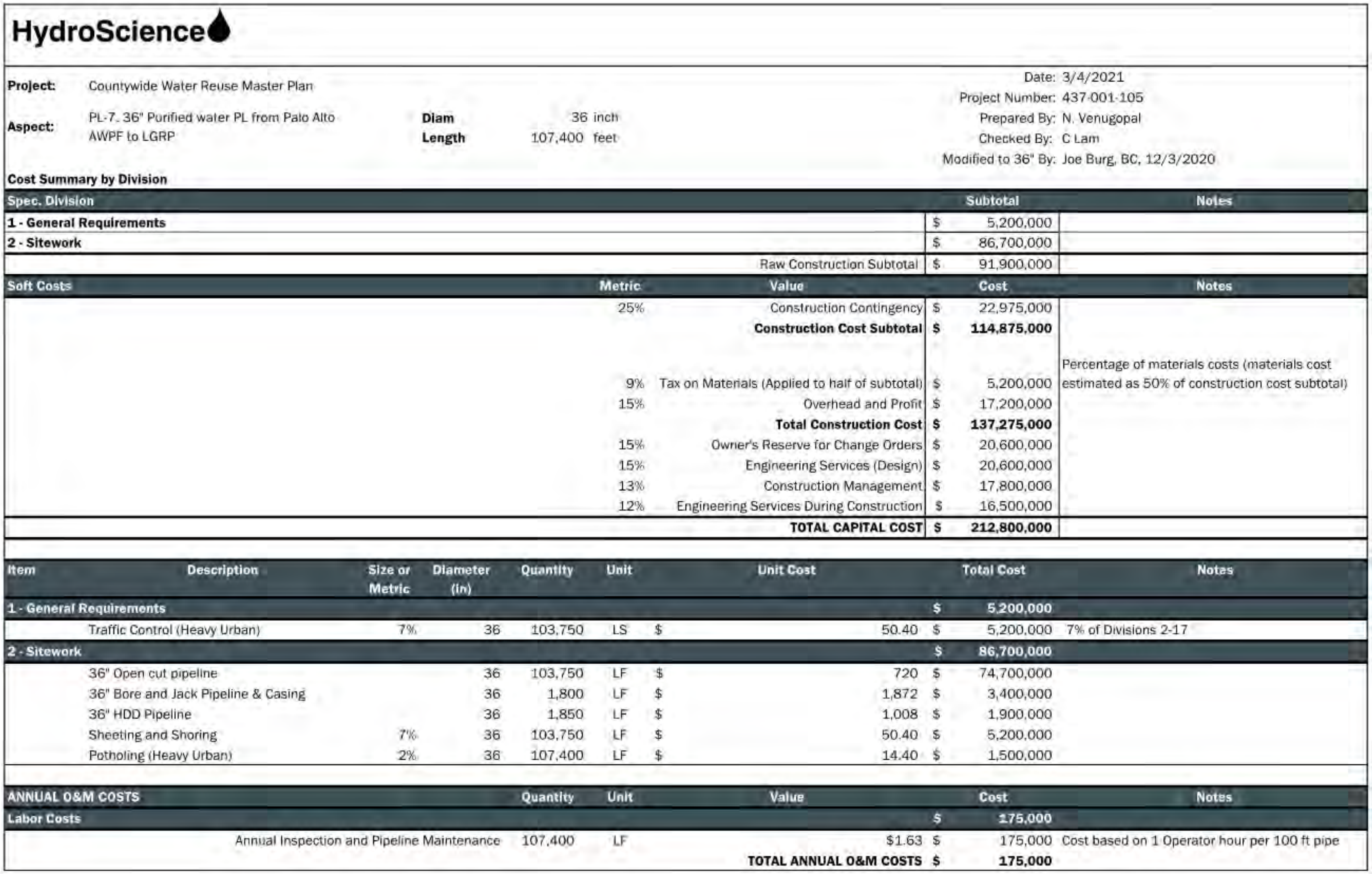
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 7,000,000	
2 - Sitework	$ 115,700,000	
Raw Construction Subtotal	$ 122,700,000	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 30,675,000	
		Construction Cost Subtotal	**$ 153,375,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 6,900,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 23,000,000	
		Total Construction Cost	**$ 183,275,000**	
	15%	Owner's Reserve for Change Orders	$ 27,500,000	
	15%	Engineering Services (Design)	$ 27,500,000	
	13%	Construction Management	$ 23,800,000	
	12%	Engineering Services During Construction	$ 22,000,000	
		TOTAL CAPITAL COST	**$ 284,100,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 7,000,000**	
	Traffic Control (Heavy Urban)	7%	48	103,750	LS	$ 67.20	$ 7,000,000	7% of Divisions 2-17
2 - Sitework							**$ 115,700,000**	
	48" Open cut pipeline		48	103,750	LF	$ 960	$ 99,600,000	
	48" Bore and Jack Pipeline & Casing		48	1,800	LF	$ 2,496	$ 4,500,000	
	48" HDD Pipeline		48	1,850	LF	$ 1,344	$ 2,500,000	
	Sheeting and Shoring	7%	48	103,750	LF	$ 67.20	$ 7,000,000	
	Potholing (Heavy Urban)	2%	48	107,400	LF	$ 19.20	$ 2,100,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-5. Cost Estimate Details: PL-7, 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-7. 36" Purified water PL from Palo Alto AWPF to LGRP

Diam 36 inch
Length 107,400 feet

Date: 3/4/2021
Project Number: 437-001-105
Prepared By: N. Venugopal
Checked By: C Lam
Modified to 36" By: Joe Burg, BC, 12/3/2020

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 5,200,000	
2 - Sitework	$ 86,700,000	
Raw Construction Subtotal	$ 91,900,000	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 22,975,000	
		Construction Cost Subtotal	**$ 114,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 5,200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 17,200,000	
		Total Construction Cost	**$ 137,275,000**	
	15%	Owner's Reserve for Change Orders	$ 20,600,000	
	15%	Engineering Services (Design)	$ 20,600,000	
	13%	Construction Management	$ 17,800,000	
	12%	Engineering Services During Construction	$ 16,500,000	
		TOTAL CAPITAL COST	**$ 212,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 5,200,000**	
	Traffic Control (Heavy Urban)	7%	36	103,750	LS	$ 50.40	$ 5,200,000	7% of Divisions 2-17
2 - Sitework							**$ 86,700,000**	
	36" Open cut pipeline		36	103,750	LF	$ 720	$ 74,700,000	
	36" Bore and Jack Pipeline & Casing		36	1,800	LF	$ 1,872	$ 3,400,000	
	36" HDD Pipeline		36	1,850	LF	$ 1,008	$ 1,900,000	
	Sheeting and Shoring	7%	36	103,750	LF	$ 50.40	$ 5,200,000	
	Potholing (Heavy Urban)	2%	36	107,400	LF	$ 14.40	$ 1,500,000	

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Labor Costs					**$ 175,000**	
	Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
				TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-6. Cost Estimate Details: PL-7, 24-inch Purified Water Pipeline from Palo Alto AWPF to LGRP

HydroScience

Project:	Countywide Water Reuse Master Plan			Date: 3/4/2021
				Project Number: 437-001-105
Aspect:	PL-7. 24" Purified water PL from Palo Alto AWPF to LGRP	**Diam**	24 inch	Prepared By: N. Venugopal
		Length	107,400 feet	Checked By: C Lam

Cost Summary by Division

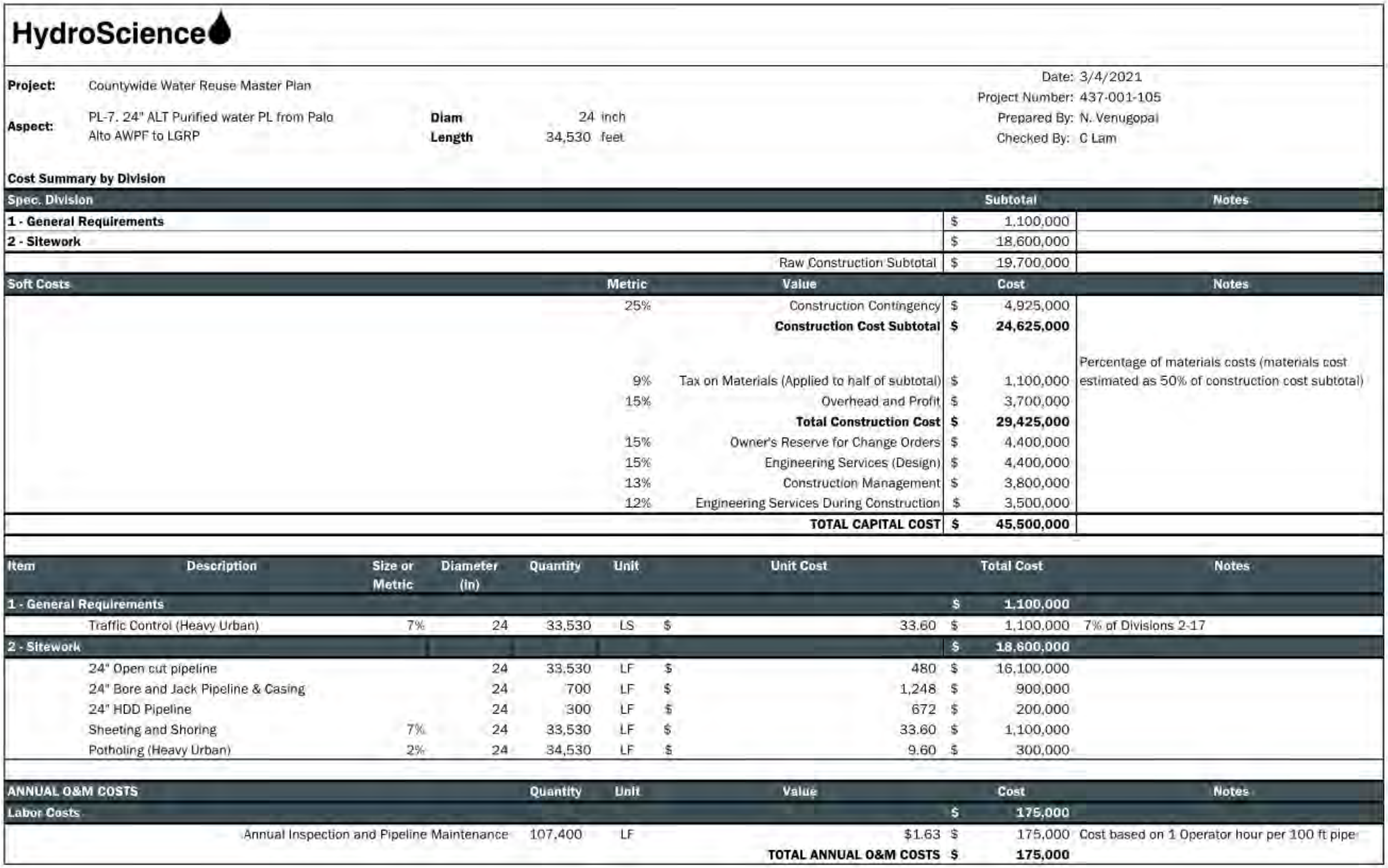
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 3,500,000	
2 - Sitework	$ 57,700,000	
Raw Construction Subtotal	$ 61,200,000	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 15,300,000	
		Construction Cost Subtotal	**$ 76,500,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 3,400,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 11,500,000	
		Total Construction Cost	**$ 91,400,000**	
	15%	Owner's Reserve for Change Orders	$ 13,700,000	
	15%	Engineering Services (Design)	$ 13,700,000	
	13%	Construction Management	$ 11,900,000	
	12%	Engineering Services During Construction	$ 11,000,000	
		TOTAL CAPITAL COST	**$ 141,700,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 3,500,000**	
	Traffic Control (Heavy Urban)	7%	24	103,750	LS	$ 33.60	$ 3,500,000	7% of Divisions 2-17
2 - Sitework							**$ 57,700,000**	
	24" Open cut pipeline		24	103,750	LF	$ 480	$ 49,800,000	
	24" Bore and Jack Pipeline & Casing		24	1,800	LF	$ 1,248	$ 2,200,000	
	24" HDD Pipeline		24	1,850	LF	$ 672	$ 1,200,000	
	Sheeting and Shoring	7%	24	103,750	LF	$ 33.60	$ 3,500,000	
	Potholing (Heavy Urban)	2%	24	107,400	LF	$ 9.60	$ 1,000,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-7. Cost Estimate Details: PL-7 Alternative, 24-inch Purified Water Pipeline from Palo Alto AWPF to LGRP



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-7. 24" ALT Purified water PL from Palo Alto AWPF to LGRP

Diam 24 inch
Length 34,530 feet

Date: 3/4/2021
Project Number: 437-001-105
Prepared By: N. Venugopal
Checked By: C Lam

Cost Summary by Division

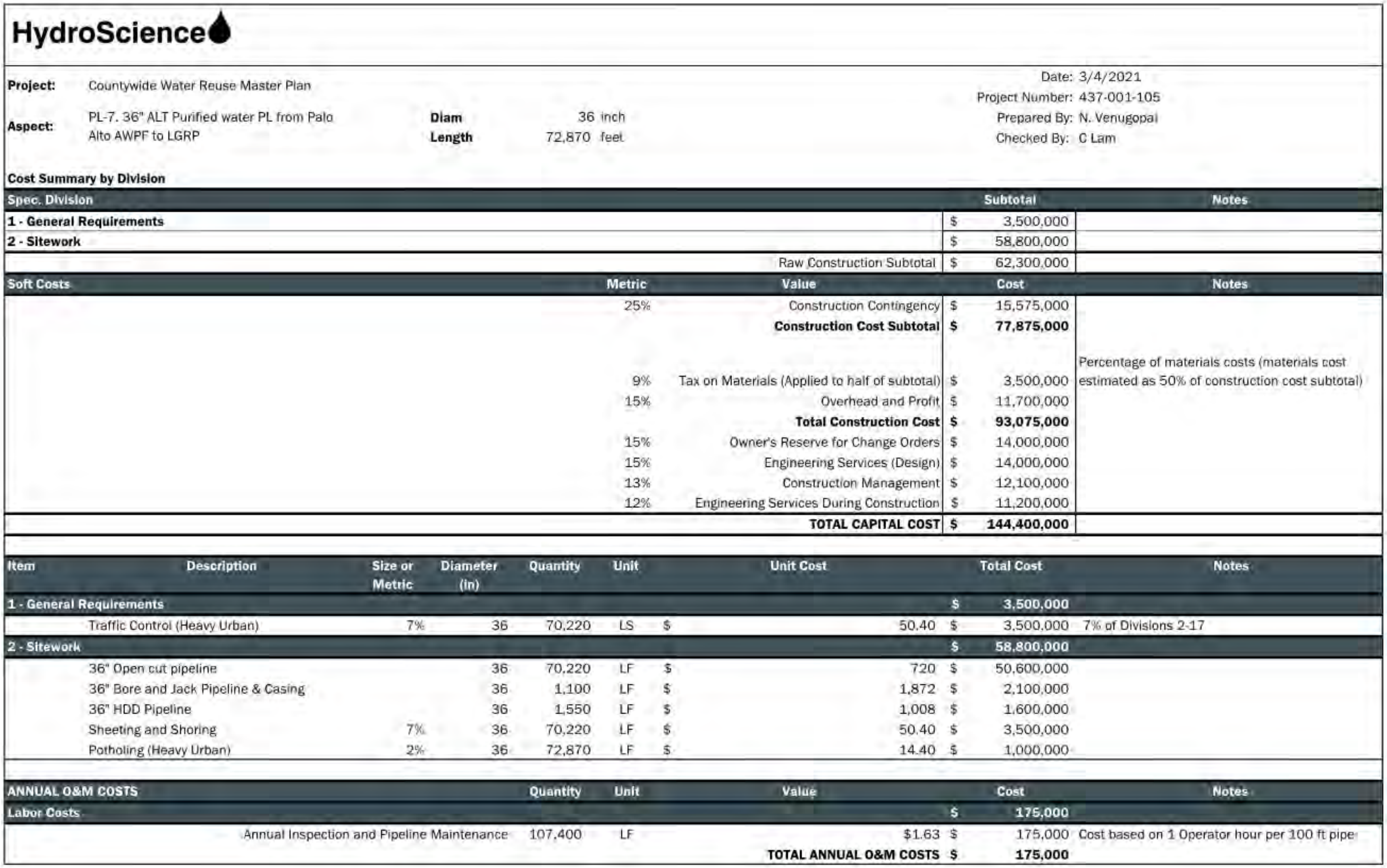
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 1,100,000	
2 - Sitework		$ 18,600,000	
	Raw Construction Subtotal	$ 19,700,000	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 4,925,000	
		Construction Cost Subtotal	**$ 24,625,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,100,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 3,700,000	
		Total Construction Cost	**$ 29,425,000**	
	15%	Owner's Reserve for Change Orders	$ 4,400,000	
	15%	Engineering Services (Design)	$ 4,400,000	
	13%	Construction Management	$ 3,800,000	
	12%	Engineering Services During Construction	$ 3,500,000	
		TOTAL CAPITAL COST	**$ 45,500,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,100,000**	
	Traffic Control (Heavy Urban)	7%	24	33,530	LS	$ 33.60	$ 1,100,000	7% of Divisions 2-17
2 - Sitework							**$ 18,600,000**	
	24" Open cut pipeline		24	33,530	LF	$ 480	$ 16,100,000	
	24" Bore and Jack Pipeline & Casing		24	700	LF	$ 1,248	$ 900,000	
	24" HDD Pipeline		24	300	LF	$ 672	$ 200,000	
	Sheeting and Shoring	7%	24	33,530	LF	$ 33.60	$ 1,100,000	
	Potholing (Heavy Urban)	2%	24	34,530	LF	$ 9.60	$ 300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-8. Cost Estimate Details: PL-7 Alternative, 36-inch Purified Water Pipeline from Palo Alto AWPF to LGRP



HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	3/4/2021
				Project Number:	437-001-105
Aspect:	PL-7. 36" ALT Purified water PL from Palo Alto AWPF to LGRP	**Diam**	36 inch	Prepared By:	N. Venugopal
		Length	72,870 feet	Checked By:	C Lam

Cost Summary by Division

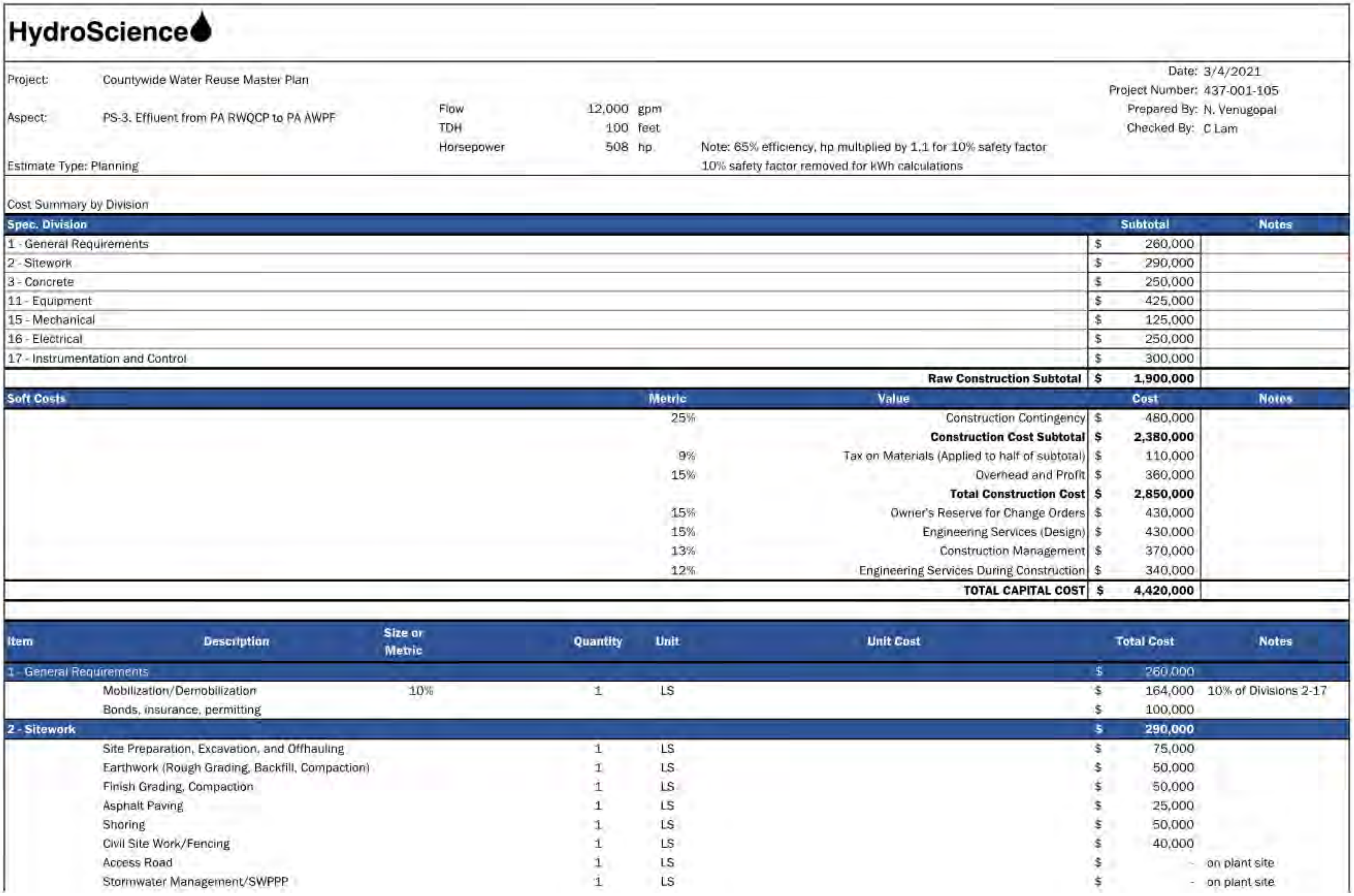
Spec. Division	Metric	Value	Subtotal	Notes
1 - General Requirements			$ 3,500,000	
2 - Sitework			$ 58,800,000	
		Raw Construction Subtotal	$ 62,300,000	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 15,575,000	
		Construction Cost Subtotal	**$ 77,875,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 3,500,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 11,700,000	
		Total Construction Cost	**$ 93,075,000**	
	15%	Owner's Reserve for Change Orders	$ 14,000,000	
	15%	Engineering Services (Design)	$ 14,000,000	
	13%	Construction Management	$ 12,100,000	
	12%	Engineering Services During Construction	$ 11,200,000	
		TOTAL CAPITAL COST	**$ 144,400,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 3,500,000**	
	Traffic Control (Heavy Urban)	7%	36	70,220	LS	$ 50.40	$ 3,500,000	7% of Divisions 2-17
2 - Sitework							**$ 58,800,000**	
	36" Open cut pipeline		36	70,220	LF	$ 720	$ 50,600,000	
	36" Bore and Jack Pipeline & Casing		36	1,100	LF	$ 1,872	$ 2,100,000	
	36" HDD Pipeline		36	1,550	LF	$ 1,008	$ 1,600,000	
	Sheeting and Shoring	7%	36	70,220	LF	$ 50.40	$ 3,500,000	
	Potholing (Heavy Urban)	2%	36	72,870	LF	$ 14.40	$ 1,000,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-9. Cost Estimate Details: PS-3, Effluent Pump Station from Palo Alto RWQCP to Palo Alto AWPF



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-3. Effluent from PA RWQCP to PA AWPF
Estimate Type: Planning

Flow 12,000 gpm
TDH 100 feet
Horsepower 508 hp

Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor
10% safety factor removed for kWh calculations

Date: 3/4/2021
Project Number: 437-001-105
Prepared By: N. Venugopal
Checked By: C Lam

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 260,000	
2 - Sitework	$ 290,000	
3 - Concrete	$ 250,000	
11 - Equipment	$ 425,000	
15 - Mechanical	$ 125,000	
16 - Electrical	$ 250,000	
17 - Instrumentation and Control	$ 300,000	
Raw Construction Subtotal	**$ 1,900,000**	

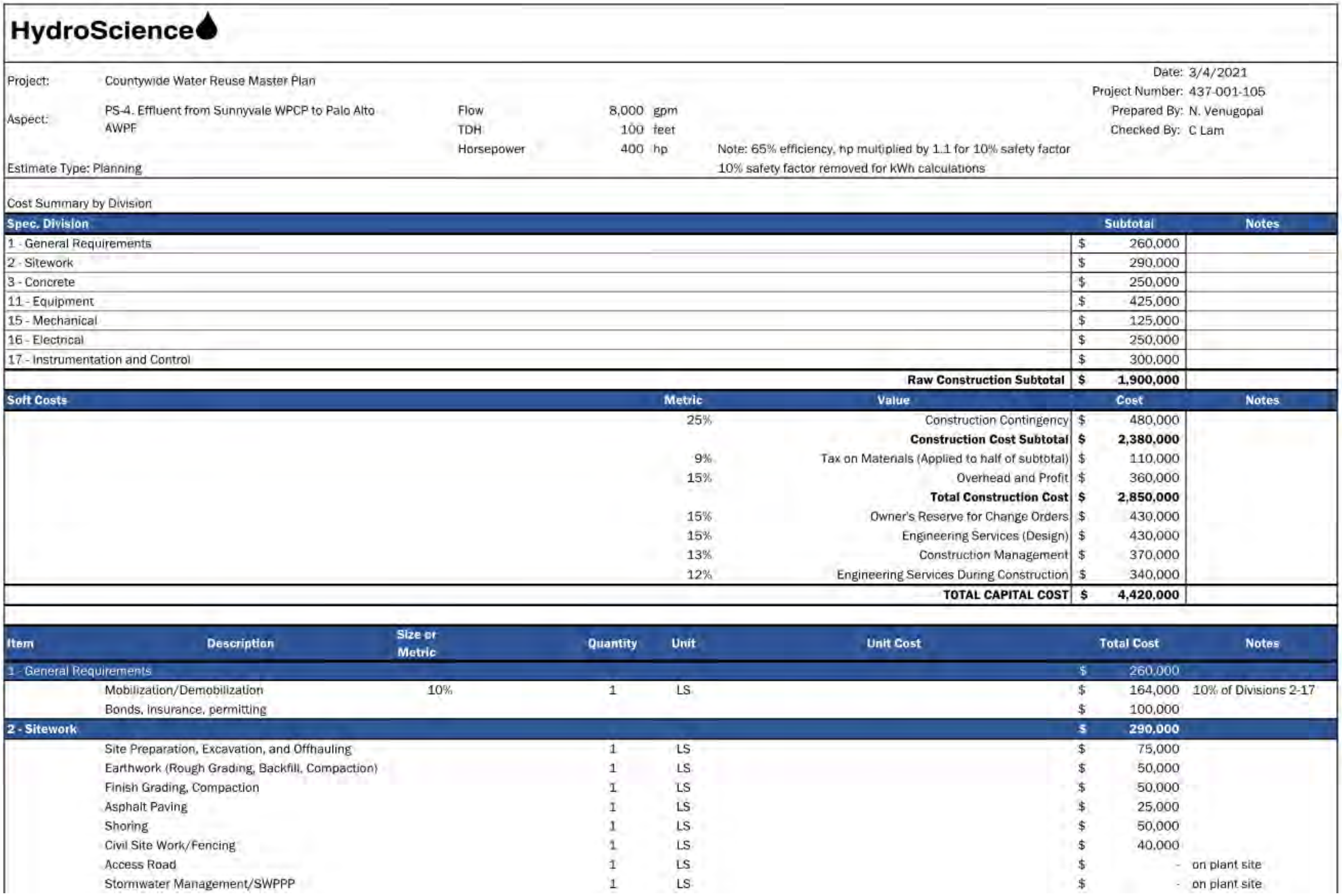
Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 480,000	
		Construction Cost Subtotal	**$ 2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 110,000	
	15%	Overhead and Profit	$ 360,000	
		Total Construction Cost	**$ 2,850,000**	
	15%	Owner's Reserve for Change Orders	$ 430,000	
	15%	Engineering Services (Design)	$ 430,000	
	13%	Construction Management	$ 370,000	
	12%	Engineering Services During Construction	$ 340,000	
		TOTAL CAPITAL COST	**$ 4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 260,000	
	Mobilization/Demobilization	10%	1	LS		$ 164,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 100,000	
2 - Sitework						**$ 290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 25,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 40,000	
	Access Road		1	LS		$ -	on plant site
	Stormwater Management/SWPPP		1	LS		$ -	on plant site

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 250,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Vaults	12 inch	1	LS		$ 60,000	
	Equipment slabs	12 inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 425,000**	
	Pump		1	LS		$ 250,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						**$ 300,000**	
	I&C/SCADA/Programming Allowance					$ 300,000	

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						**$ 22,000**	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						**$ 567,000**	
	Electricity Requirement	508 hp	2,986,139	kWh	$0.19	$ 567,000	
					TOTAL ANNUAL O&M COSTS	**$ 589,000**	

Table C-10. Cost Estimate Details: PS-4, Effluent Pump Station from Sunnyvale WPCP to Palo Alto AWPF



HydroScience

Project: Countywide Water Reuse Master Plan
Aspect: PS-4. Effluent from Sunnyvale WPCP to Palo Alto AWPF
Estimate Type: Planning

Flow 8,000 gpm
TDH 100 feet
Horsepower 400 hp
Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor
10% safety factor removed for kWh calculations

Date: 3/4/2021
Project Number: 437-001-105
Prepared By: N. Venugopal
Checked By: C Lam

Cost Summary by Division

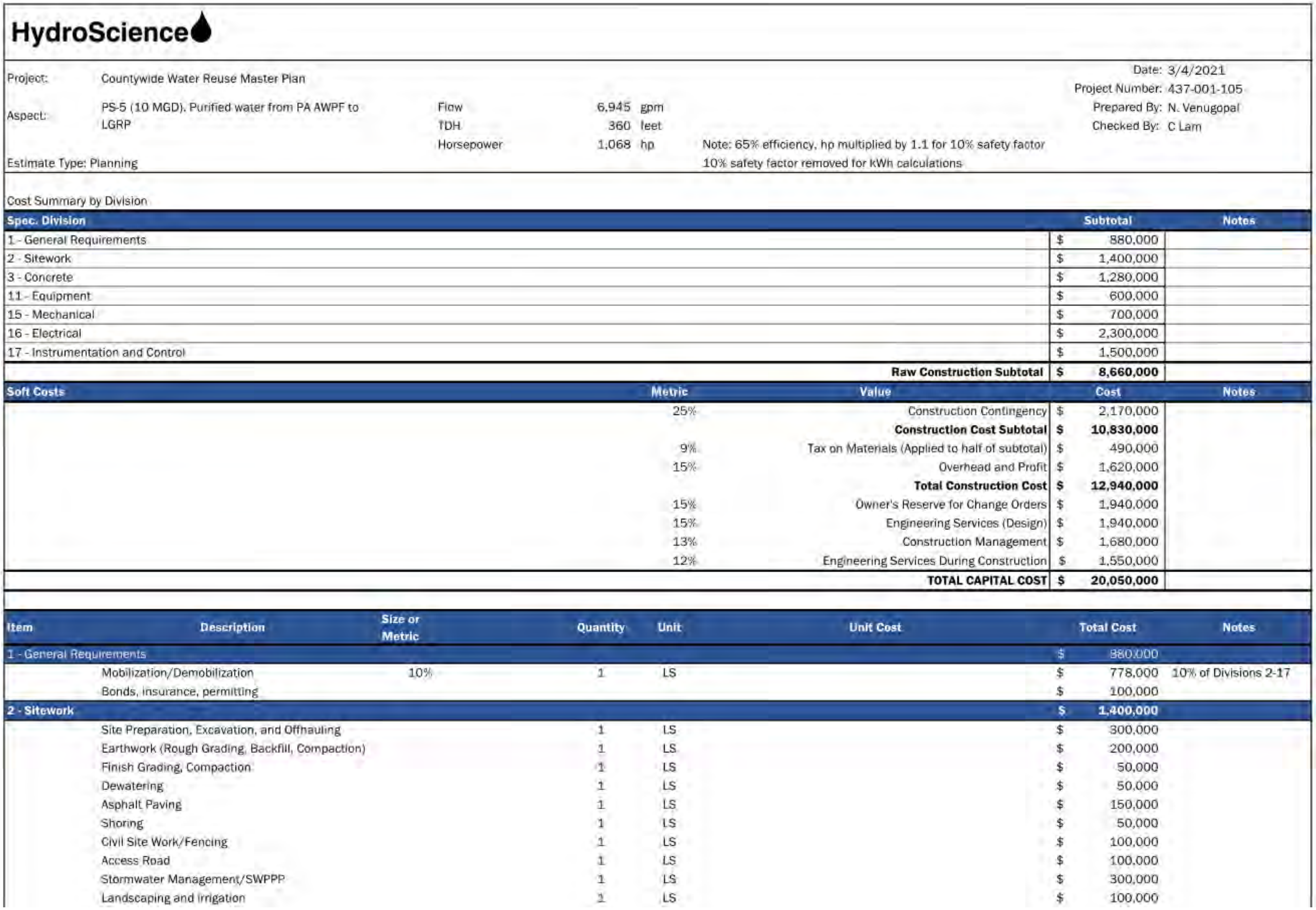
Spec. Division		Subtotal	Notes
1 - General Requirements	$	260,000	
2 - Sitework	$	290,000	
3 - Concrete	$	250,000	
11 - Equipment	$	425,000	
15 - Mechanical	$	125,000	
16 - Electrical	$	250,000	
17 - Instrumentation and Control	$	300,000	
Raw Construction Subtotal	**$**	**1,900,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	480,000	
		Construction Cost Subtotal	**$**	**2,380,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	110,000	
	15%	Overhead and Profit	$	360,000	
		Total Construction Cost	**$**	**2,850,000**	
	15%	Owner's Reserve for Change Orders	$	430,000	
	15%	Engineering Services (Design)	$	430,000	
	13%	Construction Management	$	370,000	
	12%	Engineering Services During Construction	$	340,000	
		TOTAL CAPITAL COST	**$**	**4,420,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	260,000	
	Mobilization/Demobilization	10%	1	LS		$	164,000	10% of Divisions 2-17
	Bonds, Insurance, permitting					$	100,000	
2 - Sitework						**$**	**290,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	50,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	25,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	40,000	
	Access Road		1	LS		$	-	on plant site
	Stormwater Management/SWPPP		1	LS		$	-	on plant site

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 250,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Vaults	12 inch	1	LS		$ 60,000	
	Equipment slabs	12 inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 425,000**	
	Pump		1	LS		$ 250,000	
	Surge Tank		1	LS		$ 75,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 250,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 250,000	
17 - I&C						**$ 300,000**	
	I&C/SCADA/Programming Allowance					$ 300,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 22,000**	
	Equipment		2%		$425,000	$ 8,500	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$250,000	$ 5,000	2% of Division 16
	Instrumentation		2%		$300,000	$ 6,000	2% of Division 17
Power Costs						**$ 376,000**	
	Electricity Requirement	400 hp	2,351,291	kWh	$0.16	$ 376,000	
					TOTAL ANNUAL O&M COSTS	**$ 398,000**	

Table C-11. Cost Estimate Details: PS-5 (10 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP



HydroScience

Project: Countywide Water Reuse Master Plan
Date: 3/4/2021
Project Number: 437-001-105
Prepared By: N. Venugopal
Checked By: C Lam
Aspect: PS-5 (10 MGD). Purified water from PA AWPF to LGRP
Flow 6,945 gpm
TDH 360 feet
Horsepower 1,068 hp
Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor
10% safety factor removed for kWh calculations
Estimate Type: Planning

Cost Summary by Division

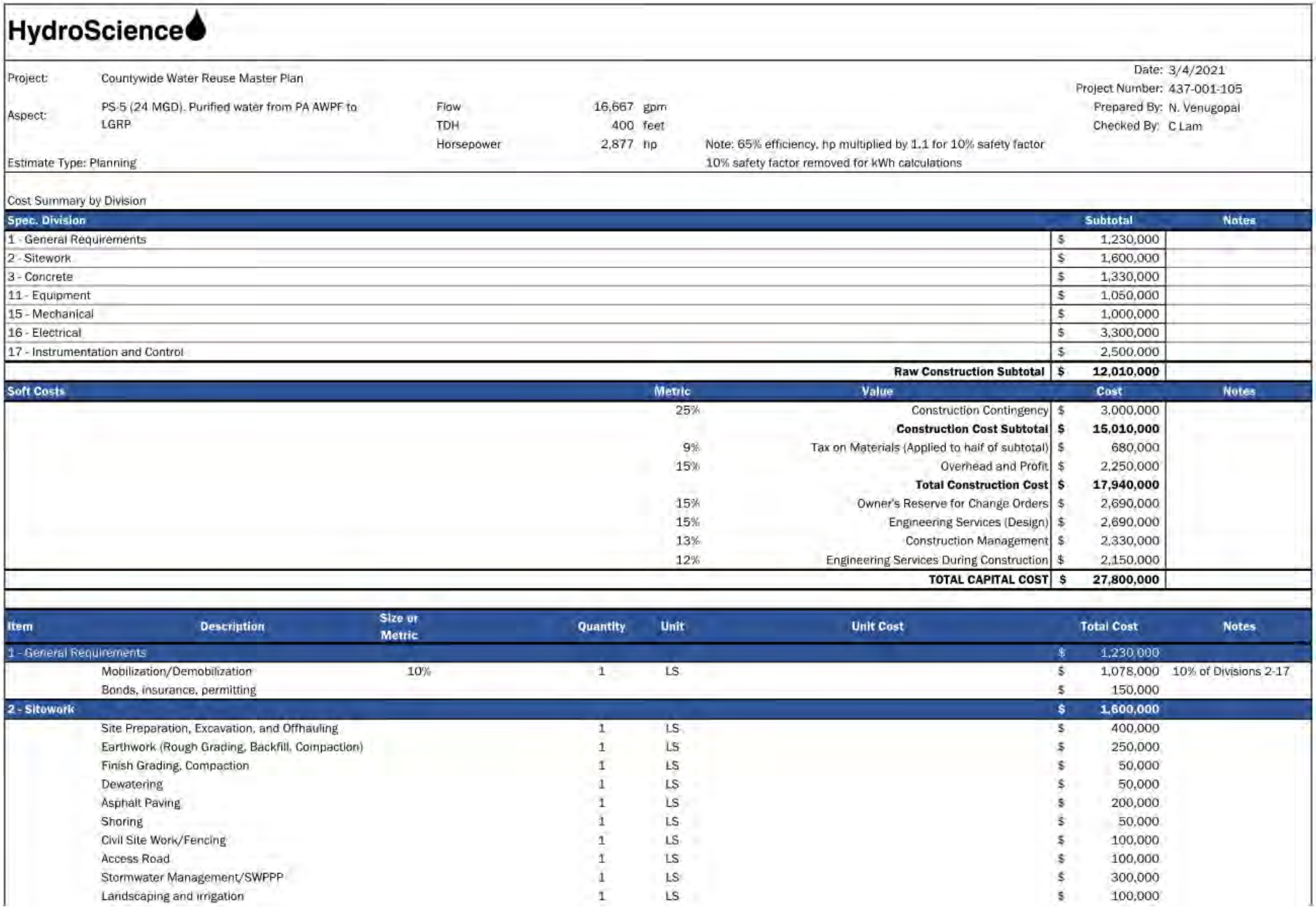
Spec. Division	Subtotal	Notes
1 - General Requirements	$ 880,000	
2 - Sitework	$ 1,400,000	
3 - Concrete	$ 1,280,000	
11 - Equipment	$ 600,000	
15 - Mechanical	$ 700,000	
16 - Electrical	$ 2,300,000	
17 - Instrumentation and Control	$ 1,500,000	
Raw Construction Subtotal	**$ 8,660,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,170,000	
		Construction Cost Subtotal	**$ 10,830,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 490,000	
	15%	Overhead and Profit	$ 1,620,000	
		Total Construction Cost	**$ 12,940,000**	
	15%	Owner's Reserve for Change Orders	$ 1,940,000	
	15%	Engineering Services (Design)	$ 1,940,000	
	13%	Construction Management	$ 1,680,000	
	12%	Engineering Services During Construction	$ 1,550,000	
		TOTAL CAPITAL COST	**$ 20,050,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						$ 880,000	
	Mobilization/Demobilization	10%	1	LS		$ 778,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 100,000	
2 - Sitework						**$ 1,400,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 300,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 200,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 50,000	
	Asphalt Paving		1	LS		$ 150,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 100,000	
	Access Road		1	LS		$ 100,000	
	Stormwater Management/SWPPP		1	LS		$ 300,000	
	Landscaping and Irrigation		1	LS		$ 100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 1,280,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 100,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 600,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 400,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 100,000	
15 - Mechanical						**$ 700,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 500,000	
16 - Electrical						**$ 2,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 102,000**	
	Equipment		2%		$600,000	$ 12,000	2% of Division 11
	Mechanical		2%		$700,000	$ 14,000	2% of Division 15
	Electrical		2%		$2,300,000	$ 46,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 1,193,000**	
	Electricity Requirement	1,068 hp	6,280,659	kWh	$0.19	$ 1,193,000	
					TOTAL ANNUAL O&M COSTS	**$ 1,295,000**	

Table C-12. Cost Estimate Details: PS-5 (24 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP



HydroScience

Project:	Countywide Water Reuse Master Plan					Date:	3/4/2021
						Project Number:	437-001-105
Aspect:	PS-5 (24 MGD). Purified water from PA AWPF to LGRP	Flow	16,667	gpm		Prepared By:	N. Venugopal
		TDH	400	feet		Checked By:	C Lam
		Horsepower	2,877	hp	Note: 65% efficiency, hp multiplied by 1.1 for 10% safety factor		
Estimate Type: Planning					10% safety factor removed for kWh calculations		

Cost Summary by Division

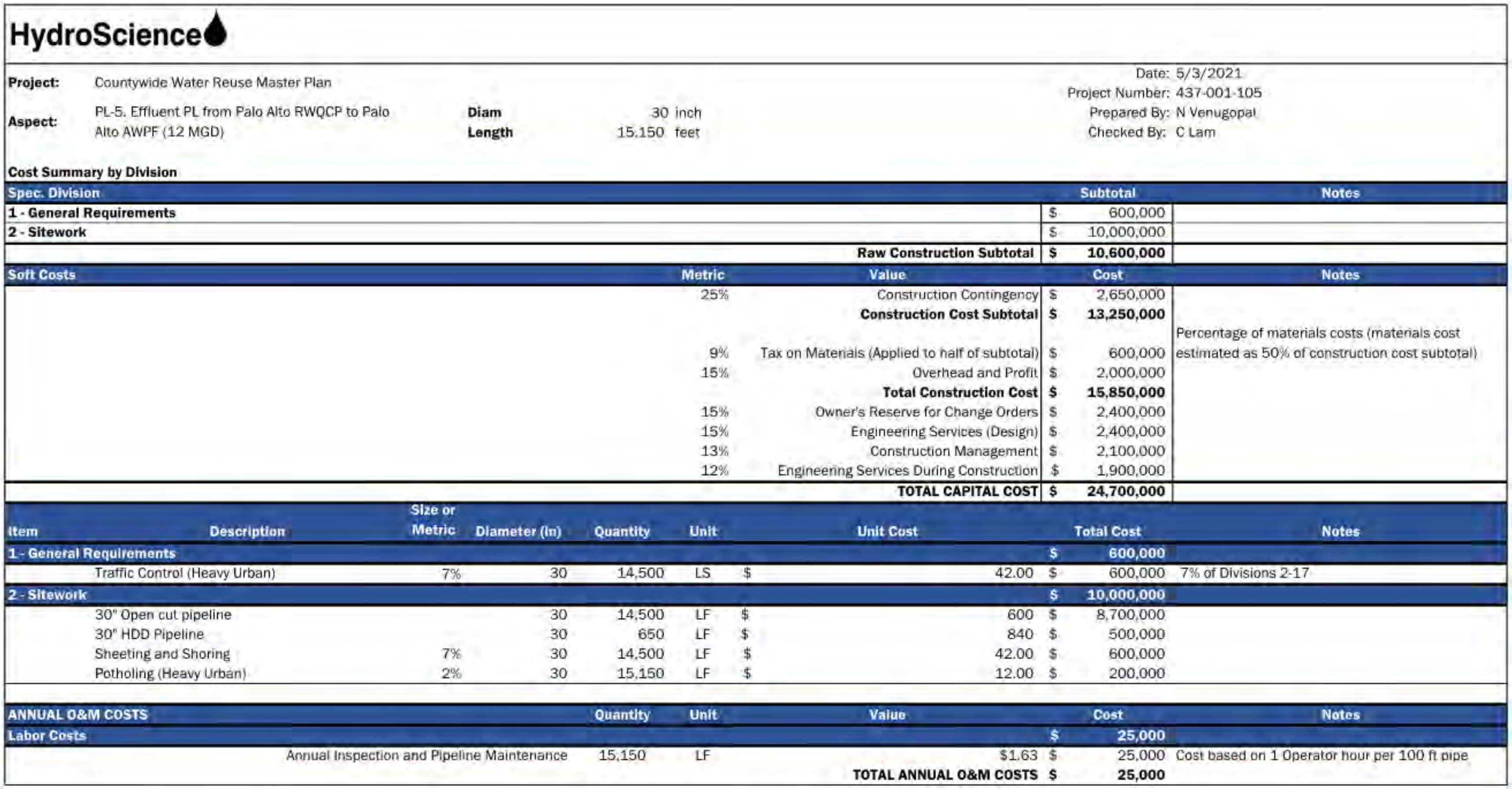
Spec. Division		Subtotal	Notes
1 - General Requirements	$	1,230,000	
2 - Sitework	$	1,600,000	
3 - Concrete	$	1,330,000	
11 - Equipment	$	1,050,000	
15 - Mechanical	$	1,000,000	
16 - Electrical	$	3,300,000	
17 - Instrumentation and Control	$	2,500,000	
Raw Construction Subtotal	**$**	**12,010,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	3,000,000	
		Construction Cost Subtotal	**$**	**15,010,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	680,000	
	15%	Overhead and Profit	$	2,250,000	
		Total Construction Cost	**$**	**17,940,000**	
	15%	Owner's Reserve for Change Orders	$	2,690,000	
	15%	Engineering Services (Design)	$	2,690,000	
	13%	Construction Management	$	2,330,000	
	12%	Engineering Services During Construction	$	2,150,000	
		TOTAL CAPITAL COST	**$**	**27,800,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						$	1,230,000	
	Mobilization/Demobilization	10%	1	LS		$	1,078,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,600,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	250,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 1,330,000**	
	Structural Concrete	18 inch	1	LS		$ 400,000	
	Vaults	12 inch	1	LS		$ 200,000	
	Equipment slabs	12 inch	1	LS		$ 150,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 200,000	
	CMU Building	25 X 40 foot	1	LS		$ 300,000	
11 - Equipment						**$ 1,050,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 800,000	
	Surge Tank		1	LS		$ 100,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 150,000	
15 - Mechanical						**$ 1,000,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 800,000	
16 - Electrical						**$ 3,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 2,500,000	
	Standby generator		1	LS		$ 800,000	
17 - I&C						**$ 2,500,000**	
	I&C/SCADA/Programming Allowance					$ 2,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 157,000**	
	Equipment		2%		$1,050,000	$ 21,000	2% of Division 11
	Mechanical		2%		$1,000,000	$ 20,000	2% of Division 15
	Electrical		2%		$3,300,000	$ 66,000	2% of Division 16
	Instrumentation		2%		$2,500,000	$ 50,000	2% of Division 17
Power Costs						**$ 3,213,000**	
	Electricity Requirement	2,877 hp	16,911,657	kWh	$0.19	$ 3,213,000	
					TOTAL ANNUAL O&M COSTS	**$ 3,370,000**	

Table C-13. Cost Estimate Details: PL-5, 30-inch Effluent Pipeline from Palo Alto RWQCP to Palo Alto AWPF



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-5. Effluent PL from Palo Alto RWQCP to Palo Alto AWPF (12 MGD)

Diam 30 inch

Length 15,150 feet

Date: 5/3/2021

Project Number: 437-001-105

Prepared By: N Venugopal

Checked By: C Lam

Cost Summary by Division

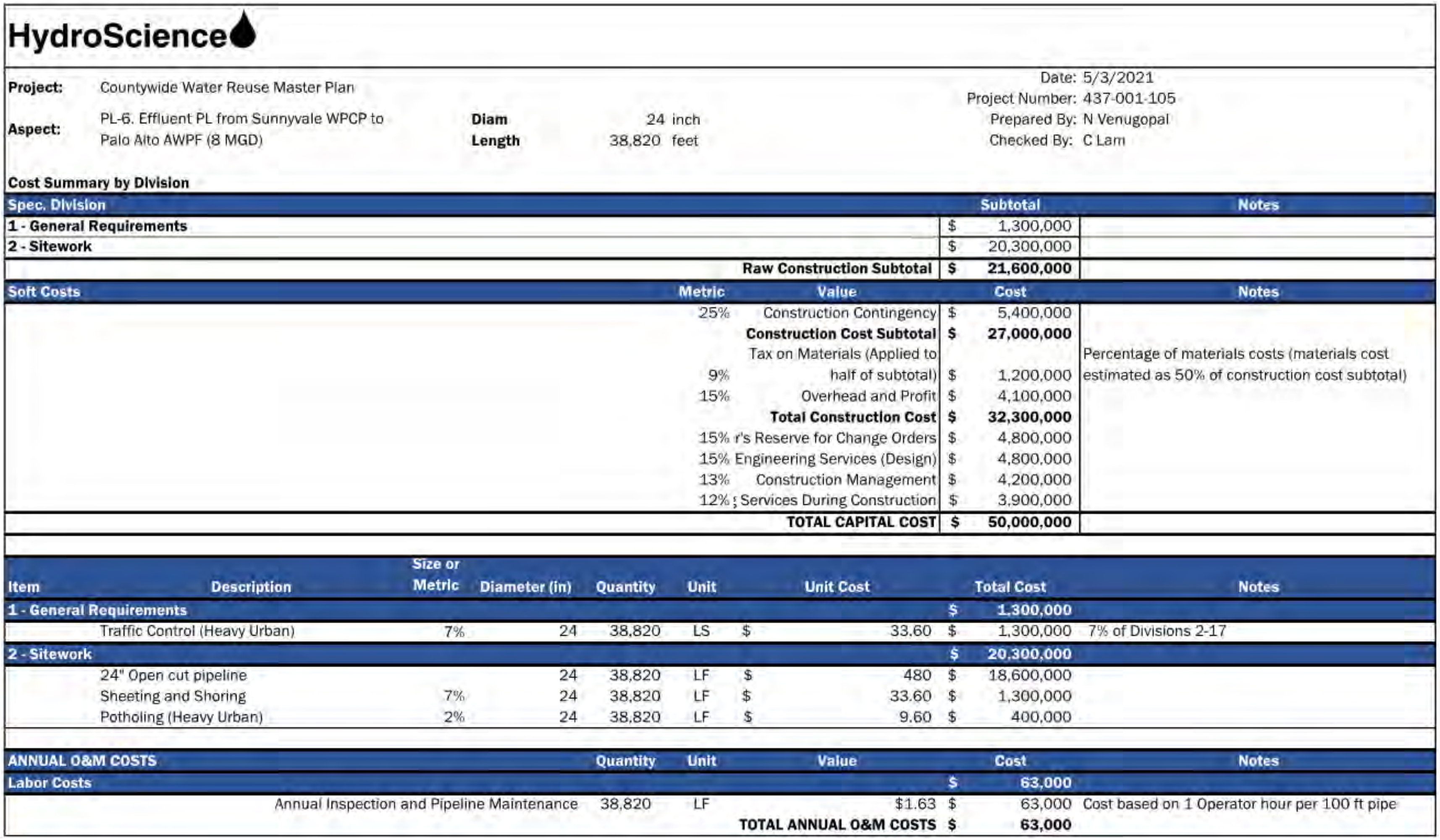
Spec. Division		Subtotal	Notes
1 - General Requirements		$ 600,000	
2 - Sitework		$ 10,000,000	
	Raw Construction Subtotal	**$ 10,600,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 2,650,000	
		Construction Cost Subtotal	**$ 13,250,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 600,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 2,000,000	
		Total Construction Cost	**$ 15,850,000**	
	15%	Owner's Reserve for Change Orders	$ 2,400,000	
	15%	Engineering Services (Design)	$ 2,400,000	
	13%	Construction Management	$ 2,100,000	
	12%	Engineering Services During Construction	$ 1,900,000	
		TOTAL CAPITAL COST	**$ 24,700,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 600,000**	
	Traffic Control (Heavy Urban)	7%	30	14,500	LS	$ 42.00	$ 600,000	7% of Divisions 2-17
2 - Sitework							**$ 10,000,000**	
	30" Open cut pipeline		30	14,500	LF	$ 600	$ 8,700,000	
	30" HDD Pipeline		30	650	LF	$ 840	$ 500,000	
	Sheeting and Shoring	7%	30	14,500	LF	$ 42.00	$ 600,000	
	Potholing (Heavy Urban)	2%	30	15,150	LF	$ 12.00	$ 200,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 25,000**	
Annual Inspection and Pipeline Maintenance	15,150	LF	$1.63	$ 25,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 25,000**	

Table C-14. Cost Estimate Details: PL-6, 24-inch Effluent Pipeline from Sunnyvale WPCP to Palo Alto AWPF



HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-6. Effluent PL from Sunnyvale WPCP to Palo Alto AWPF (8 MGD)

Diam 24 inch
Length 38,820 feet

Date: 5/3/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 1,300,000	
2 - Sitework		$ 20,300,000	
	Raw Construction Subtotal	**$ 21,600,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 5,400,000	
		Construction Cost Subtotal	**$ 27,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 1,200,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 4,100,000	
		Total Construction Cost	**$ 32,300,000**	
	15%	r's Reserve for Change Orders	$ 4,800,000	
	15%	Engineering Services (Design)	$ 4,800,000	
	13%	Construction Management	$ 4,200,000	
	12%	; Services During Construction	$ 3,900,000	
		TOTAL CAPITAL COST	**$ 50,000,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,300,000**	
	Traffic Control (Heavy Urban)	7%	24	38,820	LS	$ 33.60	$ 1,300,000	7% of Divisions 2-17
2 - Sitework							**$ 20,300,000**	
	24" Open cut pipeline		24	38,820	LF	$ 480	$ 18,600,000	
	Sheeting and Shoring	7%	24	38,820	LF	$ 33.60	$ 1,300,000	
	Potholing (Heavy Urban)	2%	24	38,820	LF	$ 9.60	$ 400,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 63,000**	
Annual Inspection and Pipeline Maintenance	38,820	LF	$1.63	$ 63,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 63,000**	

Table C-15. Cost Estimate Details: PL-7, 30-inch Purified Water Pipeline from Palo Alto AWPF to LGRP

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PL-7. Purified water PL from Palo Alto AWPF to LGRP (16 MGD)

Diam 30 inch
Length 107,400 feet

Date: 5/3/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 4,400,000	
2 - Sitework		$ 72,400,000	
	Raw Construction Subtotal	**$ 76,800,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 19,200,000	
		Construction Cost Subtotal	**$ 96,000,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 4,300,000	Percentage of materials costs (materials cost estimated as 50% of construction cost subtotal)
	15%	Overhead and Profit	$ 14,400,000	
		Total Construction Cost	**$ 114,700,000**	
	15%	Owner's Reserve for Change Orders	$ 17,200,000	
	15%	Engineering Services (Design)	$ 17,200,000	
	13%	Construction Management	$ 14,900,000	
	12%	Engineering Services During Construction	$ 13,800,000	
		TOTAL CAPITAL COST	**$ 177,800,000**	

Item	Description	Size or Metric	Diameter (in)	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 4,400,000**	
	Traffic Control (Heavy Urban)	7%	30	103,750	LS	$ 42.00	$ 4,400,000	7% of Divisions 2-17
2 - Sitework							**$ 72,400,000**	
	30" Open cut pipeline		30	103,750	LF	$ 600	$ 62,300,000	
	30" Bore and Jack Pipeline & Casing		30	1,800	LF	$ 1,560	$ 2,800,000	
	30" HDD Pipeline		30	1,850	LF	$ 840	$ 1,600,000	
	Sheeting and Shoring	7%	30	103,750	LF	$ 42.00	$ 4,400,000	
	Potholing (Heavy Urban)	2%	30	107,400	LF	$ 12.00	$ 1,300,000	

ANNUAL O&M COSTS	Quantity	Unit	Value	Cost	Notes
Labor Costs				**$ 175,000**	
Annual Inspection and Pipeline Maintenance	107,400	LF	$1.63	$ 175,000	Cost based on 1 Operator hour per 100 ft pipe
			TOTAL ANNUAL O&M COSTS	**$ 175,000**	

Table C-16. Cost Estimate Details: PS-3 (12 mgd), Purified Water Pump Station from Palo Alto RWQCP to Palo Alto AWPF

HydroScience

Project:	Countywide Water Reuse Master Plan			
Aspect:	PS-3. Effluent from PA RWQCP to PA AWPF (12 MGD)	**Flow**	8,333	gpm
		TDH	100	feet
		Horsepower	356	hp

Date: 5/3/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 230,000	
2 - Sitework		$ 320,000	
3 - Concrete		$ 240,000	
11 - Equipment		$ 335,000	
15 - Mechanical		$ 125,000	
16 - Electrical		$ 225,000	
17 - Instrumentation and Control		$ 250,000	
	Raw Construction Subtotal	**$ 1,730,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 430,000	
		Construction Cost Subtotal	**$ 2,160,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 100,000	
	15%	Overhead and Profit	$ 320,000	
		Total Construction Cost	**$ 2,580,000**	
	15%	Owner's Reserve for Change Orders	$ 390,000	
	15%	Engineering Services (Design)	$ 390,000	
	13%	Construction Management	$ 340,000	
	12%	Engineering Services During Construction	$ 310,000	
		TOTAL CAPITAL COST	**$ 4,010,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 230,000**	
	Mobilization/Demobilization	10%	1	LS		$ 149,500	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 80,000	
2 - Sitework						**$ 320,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 25,000	
	Asphalt Paving		1	LS		$ 25,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 40,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 240,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Vaults	12 inch	1	LS		$ 50,000	
	Equipment slabs	12 inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 335,000**	
	Pump		1	LS		$ 225,000	
	Surge Tank		1	LS		$ 50,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 60,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 225,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 225,000	
17 - I&C						**$ 250,000**	
	I&C/SCADA/Programming Allowance					$ 250,000	
ANNUAL O&M COSTS			Quantity	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 18,700**	
	Equipment		2%		$335,000	$ 6,700	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$225,000	$ 4,500	2% of Division 16
	Instrumentation		2%		$250,000	$ 5,000	2% of Division 17
Power Costs						**$ 398,000**	
	Electricity Requirement	356 hp	2,093,302	kWh	$0.19	$ 398,000	
					TOTAL ANNUAL O&M COSTS	**$ 416,700**	

Table C-17. Cost Estimate Details: PS-4 (8 mgd), Purified Water Pump Station from Sunnyvale WPCP to Palo Alto AWPF

HydroScience

Project: Countywide Water Reuse Master Plan

Aspect: PS-4. Effluent from Sunnyvale WPCP to Palo Alto AWPF (8 MGD)

Flow 5,555 gpm
TDH 100 feet
Horsepower 237 hp

Date: 5/3/2021
Project Number: 437-001-105
Prepared By: N Venugopal
Checked By: C Lam
Check Date:

Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 230,000	
2 - Sitework	$ 320,000	
3 - Concrete	$ 240,000	
11 - Equipment	$ 310,000	
15 - Mechanical	$ 125,000	
16 - Electrical	$ 225,000	
17 - Instrumentation and Control	$ 250,000	
Raw Construction Subtotal	**$ 1,700,000**	

Soft Costs	Metric	Value	Cost	Notes
	25%	Construction Contingency	$ 430,000	
		Construction Cost Subtotal	**$ 2,130,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$ 100,000	
	15%	Overhead and Profit	$ 320,000	
		Total Construction Cost	**$ 2,550,000**	
	15%	Owner's Reserve for Change Orders	$ 380,000	
	15%	Engineering Services (Design)	$ 380,000	
	13%	Construction Management	$ 330,000	
	12%	Engineering Services During Construction	$ 310,000	
		TOTAL CAPITAL COST	**$ 3,950,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements						**$ 230,000**	
	Mobilization/Demobilization	10%	1	LS		$ 147,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$ 80,000	
2 - Sitework						**$ 320,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$ 75,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$ 50,000	
	Finish Grading, Compaction		1	LS		$ 50,000	
	Dewatering		1	LS		$ 25,000	
	Asphalt Paving		1	LS		$ 25,000	
	Shoring		1	LS		$ 50,000	
	Civil Site Work/Fencing		1	LS		$ 40,000	
	Access Road		1	LS		$	on plant site
	Stormwater Management/SWPPP		1	LS		$	on plant site

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 240,000**	
	Structural Concrete	18 inch	1	LS		$ 100,000	
	Vaults	12 inch	1	LS		$ 50,000	
	Equipment slabs	12 inch	1	LS		$ 40,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 50,000	
11 - Equipment						**$ 310,000**	
	Pump		1	LS		$ 200,000	
	Surge Tank		1	LS		$ 50,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 60,000	
15 - Mechanical						**$ 125,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 50,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 75,000	
16 - Electrical						**$ 225,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 225,000	
17 - I&C						**$ 250,000**	
	I&C/SCADA/Programming Allowance					$ 250,000	

ANNUAL O&M COSTS			Quantity	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 18,200**	
	Equipment		2%		$310,000	$ 6,200	2% of Division 11
	Mechanical		2%		$125,000	$ 2,500	2% of Division 15
	Electrical		2%		$225,000	$ 4,500	2% of Division 16
	Instrumentation		2%		$250,000	$ 5,000	2% of Division 17
Power Costs						**$ 223,000**	
	Electricity Requirement	237 hp	1,395,451	kWh	$0.16	$ 223,000	
					TOTAL ANNUAL O&M COSTS	**$ 241,200**	

Table C-18. Cost Estimate Details: PS-5 (16 mgd), Purified Water Pump Station from Palo Alto AWPF to LGRP

HydroScience

Project:	Countywide Water Reuse Master Plan			Date:	5/3/2021
				Project Number:	437-001-105
Aspect:	PS-5. Purified water from PA AWPF to LGRP (16 MGD)	**Flow**	11,111 gpm	Prepared By:	N Venugopal
		TDH	400 feet	Checked By:	C Lam
		Horsepower	1,899 hp	Check Date:	

Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements	$	970,000	
2 - Sitework	$	1,550,000	
3 - Concrete	$	1,190,000	
11 - Equipment	$	840,000	
15 - Mechanical	$	800,000	
16 - Electrical	$	2,300,000	
17 - Instrumentation and Control	$	1,500,000	
Raw Construction Subtotal	**$**	**9,150,000**	

Soft Costs	Metric	Value		Cost	Notes
	25%	Construction Contingency	$	2,290,000	
		Construction Cost Subtotal	**$**	**11,440,000**	
	9%	Tax on Materials (Applied to half of subtotal)	$	510,000	
	15%	Overhead and Profit	$	1,720,000	
		Total Construction Cost	**$**	**13,670,000**	
	15%	Owner's Reserve for Change Orders	$	2,050,000	
	15%	Engineering Services (Design)	$	2,050,000	
	13%	Construction Management	$	1,780,000	
	12%	Engineering Services During Construction	$	1,640,000	
		TOTAL CAPITAL COST	**$**	**21,190,000**	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost		Total Cost	Notes
1 - General Requirements						**$**	**970,000**	
	Mobilization/Demobilization	10%	1	LS		$	818,000	10% of Divisions 2-17
	Bonds, insurance, permitting					$	150,000	
2 - Sitework						**$**	**1,550,000**	
	Site Preparation, Excavation, and Offhauling		1	LS		$	400,000	
	Earthwork (Rough Grading, Backfill, Compaction)		1	LS		$	200,000	
	Finish Grading, Compaction		1	LS		$	50,000	
	Dewatering		1	LS		$	50,000	
	Asphalt Paving		1	LS		$	200,000	
	Shoring		1	LS		$	50,000	
	Civil Site Work/Fencing		1	LS		$	100,000	
	Access Road		1	LS		$	100,000	
	Stormwater Management/SWPPP		1	LS		$	300,000	
	Landscaping and irrigation		1	LS		$	100,000	

Item	Description	Size or Metric	Quantity	Unit	Unit Cost	Total Cost	Notes
3 - Concrete						**$ 1,190,000**	
	Structural Concrete	18 inch	1	LS		$ 350,000	
	Vaults	12 inch	1	LS		$ 180,000	
	Equipment slabs	12 inch	1	LS		$ 160,000	
	Building slabs	18 inch	1	LS		$ 75,000	
	Miscellaneous Concrete	18 inch	1	LS		$ 160,000	
	CMU Building	25 X 40 foot	1	LS		$ 265,000	
11 - Equipment						**$ 840,000**	
	Vertical turbine pumps, cans, housing		1	LS		$ 650,000	
	Surge Tank		1	LS		$ 70,000	
	Meters (flow, pressure, power, etc.)		1	LS		$ 120,000	
15 - Mechanical						**$ 800,000**	
	Water/Sewer/Storm Utility improvements		1	LS		$ 200,000	
	Yard piping, Valves, and Appurtenances		1	LS		$ 600,000	
16 - Electrical						**$ 2,300,000**	
	Electrical Allowance (MCC, wiring, panels)		1	LS		$ 1,600,000	
	Standby generator		1	LS		$ 700,000	
17 - I&C						**$ 1,500,000**	
	I&C/SCADA/Programming Allowance					$ 1,500,000	
ANNUAL O&M COSTS			**Quantity**	**Unit**	**Value**	**Cost**	**Notes**
Consumables						**$ 108,800**	
	Equipment		2%		$840,000	$ 16,800	2% of Division 11
	Mechanical		2%		$800,000	$ 16,000	2% of Division 15
	Electrical		2%		$2,300,000	$ 46,000	2% of Division 16
	Instrumentation		2%		$1,500,000	$ 30,000	2% of Division 17
Power Costs						**$ 2,121,000**	
	Electricity Requirement	1,899 hp	11,164,611	kWh	$0.19	$ 2,121,000	
					TOTAL ANNUAL O&M COSTS	**$ 2,229,800**	

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Appendix B-1: Regulatory Compliance Strategy Technical Memorandum

Brown AND Caldwell

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75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

DRAFT

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC Internal)

Contract no.: A4120A

Appendix B1

Subject: Regulations and Regulatory Compliance

Date: June 12, 2020 (reissued October 14, 2020)

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, P.E., Brown and Caldwell Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

Prepared by: Brian Pecson, Ph.D, P.E. Trussell Technologies
California License C80440

Brie Post, P.E., Trussell Technologies
California License C86849

Reviewed by: Shane Trussell, Ph.D, P.E., Trussell Technologies
California License C66887

Melanie Holmer, P.E., Brown and Caldwell
California License C63236

Table of Contents

List of Figures iv

List of Tables v

Section 1: Introduction 1

Section 2: Indirect Potable Reuse Regulatory Overview 3
2.1 Public Health Criteria 3
    2.1.1 Evaluation Rubric for Groundwater Recharge 4
    2.1.2 Evaluation Rubric for Surface Water Augmentation 7
2.2 Environmental Compliance Criteria 8
    2.2.1 Evaluation of Groundwater Recharge Portfolios for Environmental Compliance 10
    2.2.2 Evaluation of Surface Water Augmentation Portfolios for Environmental Compliance 11

Section 3: DPR Regulatory Considerations 12
3.1 Overview 12
3.2 Pathogen Control 12
    3.2.1 Treatment 13
    3.2.2 Engineered Storage Buffers 14
    3.2.3 Blending 15
3.3 Chemical Control 16
    3.3.1 Treatment 16
    3.3.2 Source Control 20
    3.3.3 Dilution and Blending 21
3.4 Failures and Response 21
    3.4.1 Failure Prevention 22
    3.4.2 Failure Response 22
3.5 Technical, Managerial, and Financial Capacity 23
3.6 Aesthetics 23
3.7 Summary of Public Health Considerations for RWA and TWA 23

Section 4: Groundwater Recharge Portfolios 26
4.1 Public Health Criteria 26
    4.1.1 Pathogens 26
    4.1.2 Chemicals 27
    4.1.3 Source Control 28
    4.1.4 Monitoring and Control 29
    4.1.5 Retention and Response Time 30
    4.1.6 TMF Capacity 31
4.2 Environmental Compliance Criteria 32
    4.2.1 Reverse Osmosis Concentrate Management 32
    4.2.2 Product Water Release 32

4.3 Summary of GWR Portfolios 37
    4.3.1 Public Health Summary and Next Steps 37
    4.3.2 Environmental Compliance Summary and Next Steps 38
Section 5: Surface Water Augmentation Portfolio 40
5.1 Public Health Criteria 41
    5.1.1 Pathogens 41
    5.1.2 Chemicals 41
    5.1.3 Source Control 42
    5.1.4 Monitoring and Control 42
    5.1.5 Retention and Response Time 43
    5.1.6 TMF Capacity 43
5.2 Environmental Compliance Criteria 44
    5.2.1 RO Concentrate Management 44
    5.2.2 Product Water Release 44
5.3 Summary of SWA Portfolio 48
    5.3.1 Public Health Summary and Next Steps 48
    5.3.2 Environmental Compliance Summary and Next Steps 49
Section 6: Raw and Treated Water Augmentation Portfolios 51
6.1 Public Health Criteria 51
    6.1.1 Pathogens 52
    6.1.2 Chemicals 54
    6.1.3 Source Control 56
    6.1.4 Monitoring and Control 56
    6.1.5 Retention and Response Time 58
    6.1.6 TMF Capacity 58
    6.1.7 Additional Operational Modes for Greater TWA Flexibility 60
    6.1.8 West County TWA Concept 60
6.2 Environmental Compliance Criteria 61
6.3 Summary of RWA and TWA Portfolios 61
Section 7: Summary and Next Steps 63
7.1 Summary 63
7.2 Next Steps 64
Section 8: NPR System Expansion 67
Section 9: ROC Management 69
9.1 Overview of Applicable Environmental Discharge Requirements 69
9.2 Summary of ROC Management Strategies 71
Section 10: References 75

List of Figures

Figure 1-1. Summary of relevant regulations and required documentation for non-potable and potable reuse 2

Figure 3-1. Dilution provided by a range of ESBs against off-spec water events. Results assume complete mixing in the storage tanks 15

Figure 3-2. O_3/BAC pre-treatment provides additional protection against peaks of chemicals known to be incompletely removed by the FAT train 17

Figure 3-3. Excitation-emission matrices of AWPF membrane feed water, RO permeate, and RO concentrate (a) without O_3/BAC pre-treatment and (b) with O_3/BAC pre-treatment 18

Figure 3-4. Modeling of GAC removal of TCE and four low molecular weight, polar compounds known to pass through the FAT train: NDMA, 1,4-dioxane, acetone, and formaldehyde 19

Figure 3-5. GAC provides limited reduction of a 10 mg/L pulse of acetone 20

Figure 3-6. Source control for DPR may be stricter than IPR to account for the loss of the environmental buffer 21

Figure 4-1. Proposed AWPF treatment train for the groundwater recharge portfolios 26

Figure 5-1. Morgan Hill satellite treatment facility process flow diagram 40

Figure 6-1. Proposed AWPF treatment train for the raw water augmentation portfolio 51

Figure 6-2. Proposed AWPF treatment train for the treated water augmentation portfolios 51

Figure 7-1. Project timeline for Monterey One Water’s Pure Water Monterey groundwater recharge project 65

Figure 7-2. Project timeline for the City of San Diego’s North City Pure Water project for surface water augmentation 66

List of Tables

Table 2-1: Summary of Public Health Requirements for GWR and SWA 3

Table 2-2. Rubric for Evaluating Public Health Criteria in GWR Portfolios 5

Table 2-3. Rubric for evaluating public health criteria in SWA portfolios 7

Table 2-4. Summary of Environmental Compliance Requirements for GWR and SWA 9

Table 3-1. Typical Log Removal Credits of a FAT Train Compared to Potential DPR Log Reduction Requirements 13

Table 3-2. Rubric for evaluating public health criteria in RWA and TWA portfolios 24

Table 4-1. Key Attributes of the Four Groundwater Recharge Portfolios 26

Table 4-2. Pathogen Reduction Credits Expected for GWR Portfolios 1a, 2a, 2b, and 4 27

Table 4-3. Regulatory Considerations for Pathogen Control in the Groundwater Recharge Portfolios 27

Table 4-4. Regulatory Considerations for Chemical Control in the Groundwater Recharge Portfolios 28

Table 4-5. Regulatory considerations for Source Control in the Groundwater Recharge Portfolios 29

Table 4-6. Regulatory Considerations for Monitoring and control in the Groundwater Recharge Portfolios 30

Table 4-7. Regulatory Considerations for Retention and Response Time in the Groundwater Recharge Portfolios 31

Table 4 8. Regulatory Considerations for TMF in the Groundwater Recharge Portfolios 31

Table 4-9. SF Bay Basin Plan Beneficial Uses for Los Gatos Recharge Ponds and Santa Clara Subbasin 32

Table 4-10. Summary of Numeric Water Quality Objectives for the Los Gatos Recharge Ponds 33

Table 4-11. Summary of Numeric Water Quality Objectives for the Santa Clara Subbasin 34

Table 4-12. Numeric Water Quality Objectives of the Santa Clara Subbasin SNMP 35

Table 4-13. Summary of AWPF product water release regulatory complexity for each GWR portfolio 37

Table 4-14. Summary of public health regulatory considerations for the groundwater recharge portfolios 38

Table 4-15. Summary of Environmental Regulatory Considerations for the Groundwater Recharge Portfolios 39

Table 5-1. Key Attributes of the Morgan Hill Surface Water Augmentation Portfolios 40

Table 5-2. Pathogen Reduction Credits Expected for the SWA portfolio 41

Table 5-3. Regulatory Considerations for Pathogen Control in the Surface Water Augmentation Portfolio 41

Table 5-4. Regulatory Considerations for Chemical Control in the Surface Water Augmentation Portfolio 42

Table 5-5. Regulatory Considerations for Source Control in the Surface Water Augmentation Portfolio 42

Table 5-6. Regulatory Considerations for Monitoring and Control in the Surface Water Augmentation Portfolio 43

Table 5-7. Regulatory Considerations for Retention and Response Time in the Surface Water Augmentation Portfolio 43

Table 5 8. Regulatory Considerations for TMF Capacity in the Surface Water Augmentation Portfolio 44

Table 5-9. Numeric Water Quality Objectives for Anderson Reservoir 46

Table 5-10. Summary of AWPF Product Water Release Regulatory Complexity for the SWA portfolio 48

Table 5-11. Summary of Public Health Regulatory Considerations for the Surface Water Augmentation Portfolio 49

Table 5-12. Summary of Environmental Compliance Regulatory Considerations for the SWA Portfolio 50

Table 6-1. Key Attributes of the Four RWA and TWA Recharge Portfolios 52

Table 6-2. Pathogen Reduction Credits Expected for the Raw Water Augmentation Train 52

Table 6-3. Pathogen Reduction Credits Expected for the Treated Water Augmentation Train 53

Table 6-4. Regulatory Considerations for Pathogen Control in the RWA And TWA Portfolios 54

Table 6-5. Regulatory Considerations for Chemical Control in the RWA And TWA Portfolios 55

Table 6-6. Regulatory Considerations for Source Control in the RWA and TWA Portfolios 56

Table 6-7. Regulatory Considerations for Monitoring and Control in the RWA and TWA Portfolios 57

Table 6-8. Regulatory Considerations for Retention and Response Time in the RWA and TWA Portfolios 58

Table 6-9. Regulatory Considerations for TMF in the RWA and TWA Portfolios 59

Table 6-10. Summary of public health regulatory considerations for the RWA and TWA portfolios 61

Table 7-1. Summary of Regulatory Considerations for Public Health in the Potable Reuse Portfolios 63

Table 7-2. Summary of Regulatory Considerations for Environmental Compliance in the Potable Reuse Portfolios 64

Table 8-1. Summary of Regulatory Requirements for Disinfected Tertiary Recycled Water 67

Table 9-1. Summary of GHD's estimate of constituents that require ROC management for regulatory compliance 69

Table 9-2: Summary of GHD's Results Showing Percent of Production Target Achieved for Each Portfolio with Dilution Alone[a] 70

Table 9-3. Overview of ROC Management Strategies Evaluation (GHD 2020) 73

Section 1: Introduction

This Technical Memorandum (TM) evaluates the reuse portfolios in terms of regulatory compliance to identify issues that might impact their feasibility or future permitting. This information can be used in conjunction with other analyses (e.g., cost and economic analyses, governance, siting, etc.) to obtain a global view of portfolio feasibility. The regulatory analysis has been structured to 1) highlight the key regulatory considerations applicable to each portfolio, 2) identify differences between portfolios in terms of regulatory challenges and 3) note efforts that are required or may assist with future regulatory and permitting efforts. The TM divides the regulatory considerations into those impacting public health and those associated with environmental compliance. Generally, the public health requirements are specified by the Division of Drinking Water (DDW) of the State Water Resources Control Board (State Board) while the environmental criteria are specified by the regional boards.

This TM begins with a summary of the existing regulatory criteria for indirect potable reuse (IPR) (Section 2) [1] followed by a more thorough analysis of considerations for direct potable reuse (DPR) (Section 3). This overview is important to define the criteria that will be used to evaluate the portfolios. A rubric (i.e., a framework used for evaluating the potable reuse portfolios based on various regulatory criteria) has been developed for each form of reuse to assess the relative difficulty or ease of complying with those criteria. Portfolios are ranked on a blue-coded scale—light, medium, and dark blue—to cover the range from less difficult (light blue) to more difficult (dark blue) in terms of regulatory compliance. The rubrics are then used to evaluate each portfolio included in the Master Plan:

- Groundwater recharge (GWR) (Section 4): GWR Portfolios 1a, 2a, 2b, and 4
- Surface water augmentation (SWA) (Section 5): Morgan Hill SWA
- Raw water augmentation (RWA) (Section 6): RWA Portfolio 1b
- Treated water augmentation (TWA) (Section 6): TWA Portfolios 1c and 1d
- Non-potable reuse (NPR) (Section 7)

Section 8 concludes the TM with a summary and comparison of all the portfolios along with recommendations for next steps and future efforts to support regulatory and permitting efforts.

Throughout the development of this TM, there has been extensive communication with California regulators and the National Water Research Institute's Independent Advisory Panel (IAP) regarding the regulatory concepts described in this TM. Feedback received from the regulators and the IAP has been incorporated throughout the TM.

Regulations and Permits. This TM draws a distinction between the regulations that govern the various forms of reuse and the permits required to implement a project. The State Board develops water recycling requirements that are memorialized in regulations, such as Title 22 of the California Code of Regulations. These regulations specify the recycled water requirements for all types of reuse currently regulated in the state. Additionally, the State Board and other regulatory agencies throughout California and nationally develop regulations for the protection of the environment.

To uphold and enforce the regulations, the State Board and other agencies have defined the required permits and supporting documentation that must be approved for each project. These permits and regulatory deliverables take the form of documents such as National Pollutant Discharge Elimination System (NPDES) permits, water reuse requirements (WRR), waste discharge requirements (WDR), Title 22 Engineering Reports, and more. Because the required permits and documentation are similar across all types of water reuse, the portfolios will not be compared based on permit requirements. The TM focuses instead on regulatory compliance issues to allow for a comparison of each portfolio’s benefits and challenges. Figure 1-1 summarizes the regulations and required permits for each type of potable reuse. Additional discussion on the required documentation is presented in Appendix B2 – Regulatory Framework.

---

[1] Previous deliverables for the Countywide Master Plan provide an in-depth discussion of the existing regulatory frameworks for non-potable reuse and IPR via both GWR and SWA (Appendix B2 – Regulatory Framework).

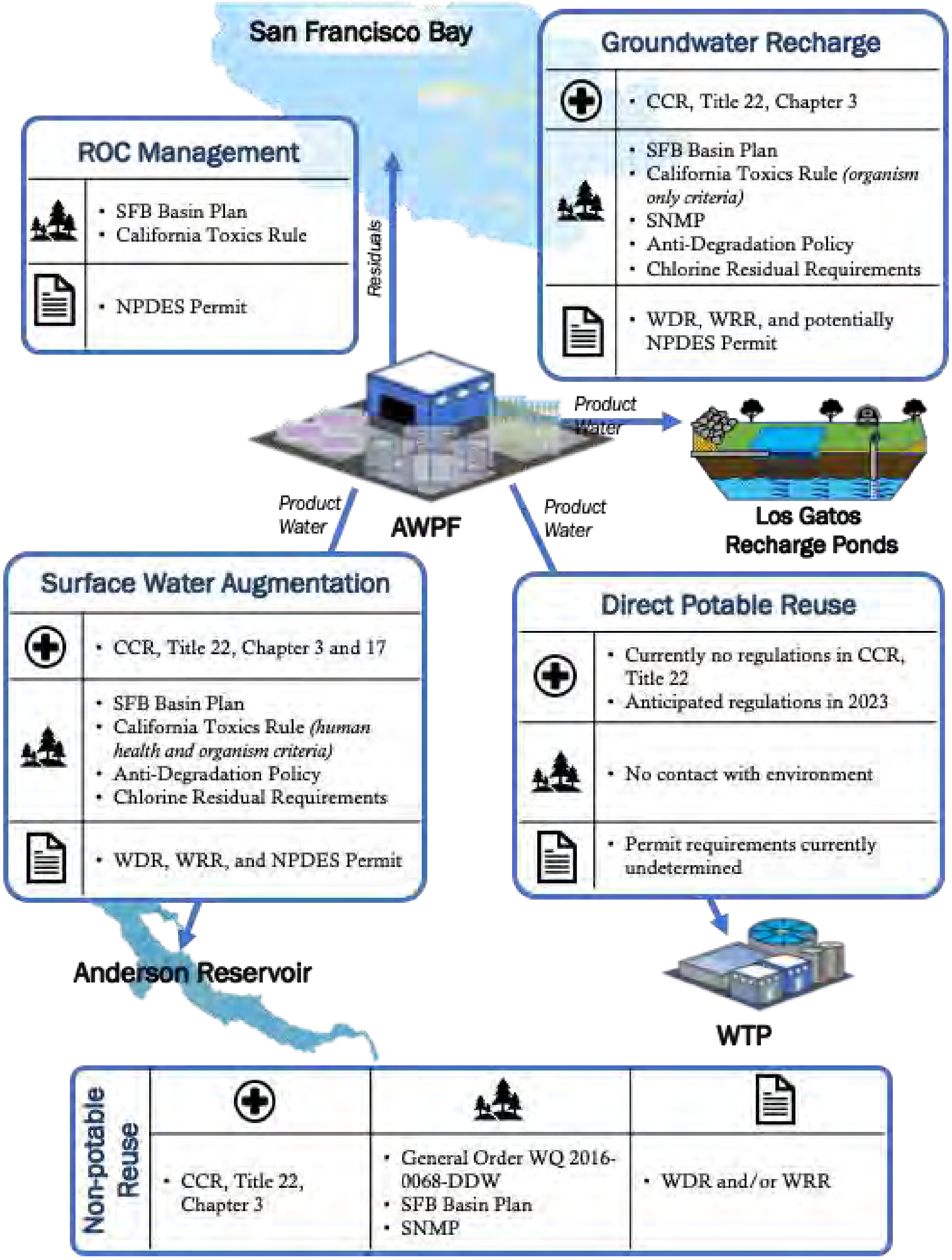
San Francisco Bay
Groundwater Recharge
CCR, Title 22, Chapter 3
SFB Basin Plan
California Toxics Rule (organism only criteria)
SNMP
Anti-Degradation Policy
Chlorine Residual Requirements
WDR, WRR, and potentially NPDES Permit
ROC Management
SFB Basin Plan
California Toxics Rule
NPDES Permit
Residuals
Product Water
Los Gatos Recharge Ponds
Product Water
AWPF
Product Water
Surface Water Augmentation
CCR, Title 22, Chapter 3 and 17
SFB Basin Plan
California Toxics Rule (human health and organism criteria)
Anti-Degradation Policy
Chlorine Residual Requirements
WDR, WRR, and NPDES Permit
Direct Potable Reuse
Currently no regulations in CCR, Title 22
Anticipated regulations in 2023
No contact with environment
Permit requirements currently undetermined
Anderson Reservoir
WTP
Non-potable Reuse
CCR, Title 22, Chapter 3
General Order WQ 2016-0068-DDW
SFB Basin Plan
SNMP
WDR and/or WRR

Figure 1-1. Summary of relevant regulations and required documentation for non-potable and potable reuse

Section 2: Indirect Potable Reuse Regulatory Overview

One benefit of pursuing an IPR project in California is that there is regulatory certainty in the form of final, adopted regulations for both GWR and SWA. Permitting IPR projects is more streamlined because these regulations provide clarity on the requirements for implementation. For GWR, there are also multiple precedents in the State, which has permitted eight projects, with the oldest in operation for nearly 60 years. Based on this experience, the regulatory community has significant first-hand knowledge of the challenges with GWR. Over the approximately 40-year period of GWR regulatory development (1976 to 2014), the State refined these requirements to adapt to its growing experience.

2.1 Public Health Criteria

A summary of the public health requirements for IPR via GWR and SWA is presented in Table 2-1. For additional in-depth discussion of the public health requirements for IPR, readers are directed to Appendix B2 – Regulatory Framework.

Table 2-1: Summary of Public Health Requirements for GWR and SWA

Potable Reuse Requirements	Groundwater Recharge	Surface Water Augmentation
Pathogen control	Log reduction value (LRV) requirements of 12/10/10 for virus/ *Giardia*/ *Cryptosporidium* (V/G/C) using a multiple-barrier approach	• 12/10/10 LRV with 100-to-1 dilution and theoretical retention time (TRT) > 120 days in the reservoir • 13/11/11 LRV with 10-to-1 dilution and TRT > 120 days • 14/12/12 LRV with 10-to-1 and 120 days > TRT > 60 days
Advanced Treatment Criteria	Full advanced treatment (FAT)—i.e., treatment of the full flow of water through reverse osmosis (RO) and an advanced oxidation process (AOP)—is required for GWR via subsurface injection and SWA. FAT is optional for spreading [a]	
Source Control	Must include: • Assessment of the fate of site-specific chemicals through the wastewater and recycled water treatment systems • Monitoring and investigation of chemical sources • Outreach program to manage and minimize the discharge of chemicals into the source water • Inventory of chemicals that may be discharged into the wastewater collection system.	
Chemical Control	In addition to Advanced Treatment Criteria, requires the monitoring of a suite of chemicals, including: • Regulated contaminants • Nitrogen compounds[b] • Unregulated contaminants, including priority toxic pollutants, site-specific unregulated chemicals, and constituents with numeric limits (NL).	
Recycled Water Contribution (RWC)	GWR projects using FAT require no diluent water by meeting the effluent total organic compound (TOC) limit of 0.5 milligrams/liter (mg/L).	N/A
Response retention time (GWR) Minimum TRT (SWA)	Minimum 2-month retention underground required. 10-log *Giardia* and *Cryptosporidium* credit for spreading projects providing ≥ 6 months of retention time. 1-log virus credit assigned for each month of retention time.	Reservoir must provide an initial minimum TRT of no less than 180 days. Alternative retention times allowed down to 60 days, though projects providing 60 to 120 days require additional pathogen control.

Table 2-1: Summary of Public Health Requirements for GWR and SWA		
Potable Reuse Requirements	**Groundwater Recharge**	**Surface Water Augmentation**
Dilution	N/A	Water withdrawn from reservoir contains no more than either of the following: • 1% recycled municipal wastewater delivered to the reservoir during any 24-hour period • 10% recycled municipal wastewater delivered to the reservoir during any 24-hour period having been subjected to additional treatment producing no less than an additional 1-log reduction of V/G/C
Monitoring and Control	Includes: • Groundwater monitoring before and after advanced water purification facility (AWPF) product water delivery • Online monitoring at the AWPF to confirm LRVs • Monthly performance reporting to DDW • Quarterly and annual monitoring and reporting of product water and groundwater for various constituents	Includes: • Reservoir monitoring before and after AWPF product water delivery • Online monitoring at the AWPF to confirm LRVs • Monthly, quarterly, and annual monitoring and reporting of product water and reservoir water for various constituents
Technical, Managerial, Financial	Requirement that project sponsors demonstrate to DDW and Regional Board that they possess either a) adequate managerial and technical capability (GWR) or b) adequate financial, managerial, and technical capability (SWA) to assure compliance with all of the requirements	

a, Per Valley Water's 2017 decision, all GWR projects will use RO treatment (i.e., FAT) to ensure protection of the groundwater quality.

b. GWR requires additional nitrogen control beyond the MCLs to achieve a total nitrogen goal of 10 mg/L.

2.1.1 Evaluation Rubric for Groundwater Recharge

To facilitate a comparison of the potable reuse portfolios, the public health requirements have been grouped into six categories:

1. Pathogen control
2. Chemical control
3. Source control
4. Monitoring and control
5. Retention and response time
6. Technical, managerial, and financial (TMF) capacity

Each portfolio in the Master Plan is compared against these six public health criteria and scored based on its ability to meet the requirements for each specific form of potable reuse.

Using the regulatory requirements for groundwater recharge described above, a rubric has been developed to evaluate and score the portfolios (Table 2-2) The rubric simplifies each category in terms of color—light blue, medium blue, and dark blue—to indicate the relative ease or difficulty of permitting with regard to each of the key public health criteria. The same color coding applies to other forms of reuse described in subsequent sections. The color-coded rankings were developed based on multiple factors, including direction provided by a) the regulations themselves, b) experience from past, permitted projects, c) project team experience with current projects, and d) publications from the State Board. A general discussion of the rankings is presented below, with more detailed and portfolio-specific discussion provided in Section 4.1.

Table 2-2. Rubric for Evaluating Public Health Criteria in GWR Portfolios

	Pathogens	Chemicals	Source Control
○	12/10/10 with ≥ 6 months or >12/10/10 with < 6 months	FAT	Source control program meets the enhanced requirements specified in IPR regulations
◒	12/10/10 with < 6 months	FAT + challenging source waters, or Non-FAT treatment	Challenging source waters or significant deviation from existing source control precedents
●		Non-FAT treatment with challenging source waters	

	Monitoring and Control	Retention and Response Time	TMF Capacity
○	Proven with many precedents Less stringent with longer retention times	≥ 6 months	Agencies with more AWPF experience and existing interagency agreements
◒	Requires coordinated monitoring and control of multiple AWPFs	2-6 months *with* compensation in treatment, monitoring, etc.	Agencies with less AWPF experience or lacking formalized interagency agreements
●		2-6 months *without* compensation in treatment, monitoring, etc.	Agencies with less AWPF experience and lacking formalized interagency agreements
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Pathogens. While the GWR regulations specify a minimum level of treatment of 12/10/10 for V/G/C, this may vary depending on the aquifer retention time available. DDW has stated that they consider an aquifer providing ≥6 months of retention time to be a significant environmental buffer. Based on the existing permitted GWR projects, providing ≥6 months of retention time and 12/10/10 allows for the most straightforward permitting, i.e., "light blue" ranking. As the retention time drops below 6 months, however, additional pathogen credits may be needed to compensate for a smaller environmental buffer (i.e., > 12/10/10). Projects seeking to provide the 12/10/10 minimum with less than 6 months of retention time may face more difficult permitting (i.e., "medium blue" ranking).

Chemicals. The existing IPR systems have demonstrated that the FAT train provides a high degree of protection against chemical constituents. A "medium blue" ranking was assigned for FAT trains only if there was uncertainty in the ability of the train to control chemicals, such as if there was significant industrial input with chemicals known to be less effectively removed by FAT. The "medium blue" ranking was also assigned for systems using a non-FAT alternative train. The "dark blue" ranking was assigned for non-FAT alternatives treating similarly difficult source waters.

Source control. There are multiple precedents for GWR source control programs that facilitate their permitting and implementation. A "light blue" ranking was assigned for most projects under the assumption that they would be enhanced to meet the source control requirements described in Table 2-1. "Medium blue" was assigned if there was a particularly challenging source water or any significant deviation from the existing precedents. There is not a statutory requirement in the Title 22 regulations to develop a formal agreement between the wastewater agency and the potable reuse agency (assuming they are different entities). While falling outside of the regulatory sphere, these agreements are beneficial to establish the roles and responsibilities of the partnering agencies, including the terms of the source control program.

Monitoring and control. The monitoring and control systems required for GWR projects are well understood based on the experience of the existing projects. While these systems provide continuous, on-line monitoring of many control points, they also benefit from the fact that water spends multiple months or years in the aquifer before extraction. The retention time provides a significant period to respond to failures, meaning that GWR monitoring and control does not need to be as stringent as potable reuse paradigms with much shorter retention times. The “medium blue” ranking was assigned to portfolios that have increased complexity, such as those that require the coordinated monitoring and control of multiple AWPFs (e.g., Portfolio 4).

Retention and response time. As discussed in the pathogens section above, projects providing ≥6 months of retention time fully leverage the benefits of the environmental barrier. DDW has stated that projects seeking <6 months should not automatically assume that their requests will be granted. Based on the reuse experience at locations like the Water Replenishment District and Padre Dam Municipal Water District (Padre Dam), gaining approval for projects providing less than two months requires significant additional interaction with DDW. These projects may also need to provide additional treatment or management barriers to compensate for the reduced benefits of the aquifer. Accordingly, “medium blue” is assigned for projects providing <6 months with some compensation and “dark blue” for those providing no compensation.

TMF capacity. DDW has not published the criteria that they use to determine a project sponsor’s TMF capacity. Consequently, assessments of TMF are not as easy to evaluate compared to the numerical criteria that DDW specifies for other topics, such as pathogen control. A “light blue” ranking was assigned for GWR portfolios that involve agencies with demonstrated experience in advanced treatment and potable reuse and have existing agreements between partner agencies establishing roles and responsibilities. For example, Orange County Water District (OCWD) and Orange County Sanitation District (OCSD) have a Joint Operating Agreement formalizing the terms of their partnership. Based on input from DDW, such agreements may be useful in demonstrating TMF capacity. “Medium blue” was assigned for projects involving agencies with less advanced treatment experience or for those where interagency agreements have not yet been formalized. “Dark blue” was assigned to projects with multiple “medium blue” factors present at the same time.

2.1.2 Evaluation Rubric for Surface Water Augmentation

Based on the regulatory requirements for SWA, the following rubric has been developed to evaluate and score SWA portfolios (Table 2-3).

Table 2-3. Rubric for evaluating public health criteria in SWA portfolios

	Pathogens	Chemicals	Source Control
○	12/10/10 with 6 mos and 100:1 or 13/11/11 with 4-6 mos and 10:1	FAT	Source control program meets the enhanced requirements specified in IPR regulations
◒	14/12/12 with 2-4 mos and 10:1	FAT + challenging source waters, or Non-FAT treatment	Challenging source waters or significant deviation from existing source control precedents
●		Non-FAT treatment with challenging source waters	

	Monitoring and Control	Retention and Response Time	TMF Capacity
○	Single agency overseeing WW/AWTF and DW with > 100:1 dilution at a single end use location	> 120-d of theoretical retention time in the reservoir	Agencies with more AWPF experience and existing interagency agreements
◒	Multiple agencies or multiple end uses or projects with < 100:1 dilution	< 120-d of theoretical retention time in the reservoir	Agencies with less AWPF experience or lacking formalized interagency agreements
●	Multiple agencies with multiple end uses or with < 100:1 dilution		Agencies with less AWPF experience and lacking formalized interagency agreements
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Like GWR, SWA projects benefit from the regulatory certainty of the 2018 SWA regulations. The regulations were developed, however, in a relatively short timeframe (approximately 2011 to 2016) meaning that they did not undergo the significant adaptation and refinement period of the GWR regulations. Furthermore, there are no SWA projects currently operating in the State. The pioneering projects (San Diego Pure Water Program and East County Advanced Water Purification Program) are providing important precedents by identifying the unique challenges of SWA. Through these two projects, DDW has gained better clarity on the important public health issues that must be dealt with during permitting.

As with GWR, the color-coded rankings were developed based on the same inputs: the SWA regulations, experience from projects pursuing SWA permits, and project team interaction with the State Board. A general discussion of the rankings is presented below with more detailed, portfolio-specific discussion provided in Section 5.1.

Pathogens. The SWA regulations provide clear guidance on the pathogen control requirements for projects providing >120 days of TRT in the reservoir: either 12/10/10 with 100:1 dilution or 13/11/11 for 10:1 dilution. The regulations introduce some vagueness for projects providing <120 days of retention time, stating that such projects will require “no less than one $\log_{10}$ reduction” of pathogens beyond the minimum requirements specified above. For example, the two SWA projects being pursued in San Diego County—the City of San Diego’s North City Pure Water project and the East County Advanced Water Purification (ECAWP) Program—fall on either side of the dilution and retention time: San Diego provides the minimum reservoir retention time (60 days) and dilution (10:1) while ECAWP provides longer retention times (>120 days) and higher dilution (100:1). San Diego’s project, therefore, relies more heavily on engineered solutions to protect public health. This in turn leads to greater scrutiny by the State Board during project review and permitting. While both projects are feasible, the level of regulatory ease or difficulty may differ based on the project’s specifics. Projects providing < 120 days are therefore assigned a “medium blue” ranking.

Chemicals. The same criteria used for the evaluation of chemical control in GWR are also applied for SWA.

Source control. The same criteria used for the evaluation of source control in GWR are also applied for SWA.

Monitoring and control. While the monitoring and control systems may be similar to GWR, SWA requires greater coordination due to the presence of both an AWPF and a surface water treatment plant (WTP). This coordination must be formalized in a Joint Plan that describes corrective actions to take in the event of water quality issues and specifies the requirements for communication among the water recycling agency, the potable water provider, and the State and regional boards during such events. This plan must be reviewed and approved by both the State and regional boards. Portfolios were given a "light blue" ranking if they a) minimized complexity by having both the AWPF and WTP under a single agency, b) provided a more significant environmental barrier with > 100:1 dilution, and c) used the augmented reservoir water at a single end-use location. "Medium blue" was assigned to projects meeting all but one of these criteria, and "dark blue" to those diverging from these criteria in multiple aspects.

Retention and response time. Like with GWR, DDW requires a greater degree of interaction for projects providing less than a minimum degree of retention time. In the SWA regulations, the value that triggers additional oversight is 120 days; at this point, DDW begins to assess the project's requirements on a case-by-case basis (see discussion on pathogens above). Consequently, a "light blue" ranking is assigned to projects providing >120 days and "medium blue" to those providing <120 days.

TMF capacity. As with GWR, a "light blue" ranking was assigned for SWA portfolios that involve agencies with demonstrated experience in advanced treatment and potable reuse and have existing agreements between partner agencies establishing roles and responsibilities. "Medium blue" was assigned for projects involving agencies with less advanced treatment experience or for those where interagency agreements have not yet been formalized. "Dark blue" was assigned to projects with multiple "medium blue" factors present at the same time.

2.2 Environmental Compliance Criteria

Each portfolio has various environmental compliance criteria that must be met, but the anticipated level of complexity for compliance varies across portfolios. In each case, both a reverse osmosis concentrate (ROC) and AWPF product water will be produced. ROC will be discharged to the environment in every portfolio and must be done so in accordance with applicable regulations. For all of the IPR portfolios, the AWPF product water will pass through an environmental buffer that must also comply with environmental regulations. The DPR portfolios in the Master Plan do not release purified water to the environment and so only need to consider ROC discharge requirements.

To assess the relative ease or complexity of environmental compliance, each portfolio was evaluated on ROC management and AWPF product water releases. Within each category, there are environmental requirements defined in various regulations. Table 2-4 provides a summary of the environmental requirements for each type of discharge. Note that this is not a complete list of the environmental regulations that may be applicable to the portfolios. Other considerations, such as California Environmental Quality Act (CEQA) compliance, review and approvals from the California Department of Fish and Wildlife and from the San Francisco Bay Conservation and Development Commission, etc., will be important during later phases of project development. The environmental regulations included in Table 2-4 were selected because they define the water quality requirements for the discharges and are, therefore, likely to have the largest impact on potential design elements of the portfolios.

Table 2-4. Summary of Environmental Compliance Requirements for GWR and SWA

<table>
<tr><th>Environmental Regulation</th><th>Groundwater Recharge</th><th>Surface Water Augmentation</th></tr>
<tr><td colspan="3">RO Concentrate Management</td></tr>
<tr><td>San Francisco (SF) Bay Basin Plan and Central Coastal Basin Plan</td><td colspan="2">Narrative and numeric Surface Water Quality Objectives for discharges to the Artesian Slough (San José-Santa Clara Regional Wastewater Facility [SJ/SC RWF]), South San Francisco Bay and Matadero Creek (Palo Alto RWQCP), and Moffett Channel (Sunnyvale WPCP).
Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, radioactivity, toxicity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and temperature.
Numeric objectives include:
• Bacteria
• Dissolved oxygen
• pH
• Turbidity
• Un-ionized ammonia
• Chemical constituents</td></tr>
<tr><td>California Toxics Rule</td><td colspan="2">Numeric objectives applicable to the SF Bay for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D2. These objectives are applicable to all surface waters in California with defined beneficial uses that do not include municipal and domestic supply (MUN).</td></tr>
<tr><td colspan="3">Product Water Release</td></tr>
<tr><td>SF Bay Basin Plan</td><td>Narrative and numeric surface water and groundwater quality objectives for product water delivered to the Los Gatos Recharge Ponds (LGRP) and Santa Clara Subbasin.
Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, toxicity, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, and tastes and odors.
Numeric objectives include:
• Bacteria
• Dissolved oxygen
• pH
• Turbidity
• Temperature
• Un-ionized ammonia
• Additional chemical constituents</td><td>Narrative and numeric surface water quality objectives for product water delivered to Anderson Reservoir.
Narrative objectives include bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, toxicity, salinity, sediment, settleable material, suspended material, sulfide, and tastes and odors.
Numeric objectives include:
• Bacteria
• Dissolved oxygen
• pH
• Radioactivity
• Turbidity
• Temperature
• Un-ionized ammonia
• Additional chemical constituents including maximum contaminant levels (MCL) and secondary maximum contaminant levels (sMCL)</td></tr>
<tr><td>California Toxics Rule</td><td>Numeric objectives applicable to the LGRP for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D2. These objectives are applicable to all surface waters in California with defined beneficial uses that do not include MUN.</td><td>Numeric objectives applicable to Anderson Reservoir for the priority toxic pollutants described in the CTR 131.38 (b)(1), Table Columns B1, B2, and D1. These objectives are applicable to all surface waters in California with defined beneficial uses that do include MUN.</td></tr>
<tr><td>Salt and Nutrient Management Plan</td><td>Numeric groundwater quality objectives that align with the SF Bay Basin Plan for total dissolved solids (TDS), nitrate (as NO_3), and nitrate plus nitrite (as N)</td><td>N/A</td></tr>
<tr><td>Anti-Degradation Policy</td><td colspan="2">The existing high quality of LGRP and Anderson Reservoir must be maintained per State Board Resolution 68-16[a]</td></tr>
<tr><td>Chlorine Residual Requirements</td><td colspan="2">The EPA has established national criteria[b] for chlorine residual concentrations to protect freshwater aquatic life, including:
• criterion maximum concentration (CMC) (1-hour) value of 19 micrograms per liter (µg/L)
• criterion continuous concentration (CCC) (4-day) value of 11 µg/L</td></tr>
</table>

a. *Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Waters in California was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.*

b. *U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.*

Ultimately, the selected portfolio will require a number of permits to ensure compliance with these regulations. Purified water released to waters of the United States require NPDES permits, and so would future ROC discharges. Discharges to waters of California require WDR/WRR permits, and so future product water releases will likely include these permitting efforts for the GWR, SWA, and certain DPR portfolios (if an environmental buffer is used). It is possible that some product water releases will also require NPDES permits, which will be up to the discretion of the Regional Board. WDR/WRR and NPDES permits are administered by the Regional Board to ensure compliance with all applicable environmental regulations. As discussed, the present evaluation is focused on the regulations because it is assumed that the necessary permits would be obtained so long as all applicable regulatory requirements are met.

Valley Water is leading a ROC management analysis that assesses strategies for each IPR portfolio, including GWR Portfolios 1a, 2a, 2b, and 4 as well as an SWA project at Morgan Hill. The four GWR projects will produce ROC that will be discharged to the SF Bay, whereas the SWA project at Morgan Hill requires an alternative ROC management strategy. For all potential projects, the requirements described in the SF Bay Basin Plan should be met. For additional information regarding ROC management strategies, refer to Section 9 of this TM.

This document also assesses AWPF product water compliance for all portfolios that include the use of environmental buffers, including Portfolios 1a, 2a, 2b, 4, and SWA at Morgan Hill. Similar to ROC discharge, all product water releases must comply with the SF Bay Basin Plan. Additional regulations may also apply, depending on the planned receiving water type and location, such as the California Toxics Rule (CTR), Salt and Nutrient Management Plans (SNMP), the Anti-Degradation Policy, and chlorine residual requirements. All of the relevant environmental regulations were introduced and summarized in Appendix B2 – Regulatory Framework. This document further describes regulations that specifically relate to each portfolio and assesses the complexity of complying with the regulation.

The IAP recommended exploring an innovative permitting approach wherein the AWPF product water released into the environment would be characterized as a new basic water supply instead of as a waste discharge. The implications of this re-characterization are that NPDES permits and/or WDR/WRR permits would no longer be issued and would be replaced by an integrated Clean Water Act/California Water Code-Safe Drinking Water Act (SDWA) permit. As described by the IAP, "A potential benefit of the integrated permit approach is that a number of State Water Board (SWB) policies and regulations, such as anti-degradation and the CTR, may not directly apply to SDWA permitting. Further, human-health-related CTR issues are addressed by the SWB constituents of emerging concern (CEC) policy and the [Title 22] regulations," (Crook et al. 2020). It is important to note that existing GWR and SWA projects that have been or are currently being implemented characterize AWPF product water as a waste discharge and comply with all applicable environmental requirements described in this TM. Therefore, the new strategy proposed by the IAP may be most suitable for DPR projects, where precedents have not been set and the extent to which the AWPF product water is released into the environment is minimal.

The following subsections introduce the considerations for assessing relative complexity of environmental regulatory compliance relevant to GWR and SWA projects. Each portfolio is ranked and scored based on AWPF product water considerations for GWR (Section 4.2) and SWA (Section 5.2).

2.2.1 Evaluation of Groundwater Recharge Portfolios for Environmental Compliance

The ROC management strategies for the GWR portfolios include eventual discharge to South SF Bay, though the mechanism of discharging ROC varies depending on the portfolio. Each ROC management approach comes with complexity and challenges, with some portfolios having more potential challenges than others. There are a number of considerations that can impact the complexity of a ROC permitting effort, including:

- How many agencies will be responsible for monitoring and compliance with the discharge permit?

- Can an existing waste discharge outfall be used, or will a new outfall need to be constructed?
- Are all applicable water quality objectives met or will an innovative permitting strategy be required?
- Will multiple ROC discharge permits be needed (e.g., are multiple ROC discharge locations used)?
- Are there rare or endangered species with habitat that could be impacted by the ROC discharge?

For additional information regarding ROC management strategies, refer to Section 9 of this TM.

On the AWPF product water release side, additional environmental regulations apply. All of the GWR portfolios involve the release of product water to LGRP that will eventually percolate into the Santa Clara Subbasin. The relative complexity of environmental regulatory compliance is, therefore, similar across the GWR portfolios. There are differences in complexity, however, when comparing the GWR portfolios to the option for SWA at Morgan Hill, where the product water is sent to Anderson Reservoir. Considerations that can impact the complexity of releasing product water into the environment include:

- What is the mode of contact between the AWPF product water and the environment (e.g., surface spreading, groundwater injection, reservoir augmentation)?
- What beneficial uses and associated water quality objectives are applicable for the release location?
- Are product water releases from multiple AWPFs being sent to the same location?
- How many agencies will be responsible for monitoring and compliance with the discharge permit?

2.2.2 Evaluation of Surface Water Augmentation Portfolios for Environmental Compliance

A similar approach was used to rate and score the complexity of environmental regulatory compliance for the SWA portfolio as for the GWR portfolios.

For the product water release, the same considerations that impact relative complexity of compliance are applicable to the SWA portfolio. Similar environmental regulations apply with key distinctions, including the fact that Anderson Reservoir is currently used as a drinking water source and that significant percolation into the Santa Clara Subbasin is not expected.

Section 3: DPR Regulatory Considerations

3.1 Overview

The key difference between IPR and DPR schemes is the elimination or reduction of the environmental buffer. This distinction is important because DPR schemes will not be able to rely on the environment to improve water quality or provide response time to address issues in water quality. A more immediate connection between treatment and consumption presents unique challenges for DPR. The challenges impact how DPR systems adapt to multiple issues: 1) pathogen control, 2) chemical control, 3) aesthetics, 4) failures, and 5) TMF capacity. The goal of the following sections is to provide perspective for why these are important issues for DPR, describe potential pathways for addressing them in the Master Plan portfolios, and develop criteria with which to evaluate the RWA and TWA portfolios.

3.2 Pathogen Control

Pathogens present a unique public health challenge because even a short-term failure to control their concentrations can result in infection and illness[2]. Pathogen control must, therefore, be consistent and reliable to protect the public. In IPR, treatment is balanced with other elements that protect public health, most notably the environmental buffer that provides both additional treatment and time to respond to failures. As this element decreases, the system may need to be rebalanced to rely more heavily on other elements for public health protection. The State Board recently identified treatment as an element that will be enhanced in DPR settings:

> The loss of the benefits of the environmental buffer must be offset with equally effective and reliable engineered treatment proximate to the drinking water user. (SWRCB 2019b)

The consequence of this rebalancing will likely be greater redundancy in pathogen control beyond what has been required for IPR:

> To minimize the chance that [log removal values] LRVs necessary to meet the health objective are not consistently met, DPR projects must provide log reduction capacity in excess of the basic LRVs (redundant LRV treatment). (SWRCB 2019b)

Insight into the potential future DPR LRV requirements can be gained by evaluating the pathogen control requirements in IPR. As IPR projects move from large to small environmental buffers, higher degrees of pathogen control are required. This is most clearly codified in the SWA regulations that require an additional 1-log reduction for projects with shorter retention times (i.e., less than 4 months) and lower degrees of dilution (i.e., less than 100:1). The combination of both of these conditions leads to an additional 2-log requirement above the base 12/10/10 LRVs. For example, the permit for San Diego's North City Pure Water Project requires minimum LRVs of 14/12/12 due to the fact that the Miramar Reservoir provides only a 2-month retention time with a 10:1 dilution. Based on these precedents, the State Board may require DPR systems to provide LRVs in excess of the 14/12/12 requirements for SWA.

To help with regulatory development, the State is actively investigating the relationship between treatment and risk as a part of their first priority DPR research project, DPR-1 (Pecson 2019). Risk is an important concept because previous drinking water and potable reuse regulations have established treatment goals based on meeting acceptably low levels of risk. One way that the State may ensure greater consistency of treatment performance is to shift from an annual risk goal to a daily risk goal. By looking at compliance on a shorter timescale, individual days with poorer performance and higher risk cannot be buffered out by other days with higher performance. This shift may be one of the means by which they justify the increase in pathogen removal requirements for DPR.

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[2] Most toxic chemicals of concern are present at sufficiently low levels in treated wastewater that they would require repeated, chronic, long-term exposure to lead to a significant public health impact.

> Rather than allow water microbial quality and risk of infection to fluctuate significantly and meet the risk objective on an annual average, the treatment scheme is expected to be regulated to provide consistently safe water by imposing a daily risk objective that would not exceed 2.7×10^{-7} per day. (SWRCB 2019b)

The outcomes of the DPR research are not expected until 2020, and the State will also likely convene an Expert Panel to assist with the review of the future DPR regulations. As a result, greater clarity on the specific values may not be available until closer to the 2023 regulatory deadline. For the purposes of this TM, it is assumed that the pathogen requirements for DPR will be no less than 15/13/13 for both RWA and TWA. DDW stated during the June 9, 2020 meeting, at which members of the Project Team met with DDW to solicit feedback on the proposed Master Plan, that they do not have additional clarity on the future pathogen control requirements, but that 15/13/13 appeared to be a reasonable estimate that accounts for their stated concerns.

Given these targets, it is unlikely that the FAT train alone will be sufficient to meet the future pathogen requirements, even with an additional free chlorine disinfection step (Table 3-1). An additional barrier or barriers may be needed to meet the DPR pathogen LRVs. Ideally, the additional barriers selected for pathogen control should also help meet the requirements for other DPR criteria, including chemical control and aesthetics. These topics are covered in the following sections.

Table 3-1. Typical Log Removal Credits of a FAT Train Compared to Potential DPR Log Reduction Requirements

Unit Processes	Microbiological Log Removal Credits		
	Viruses	*Giardia*	*Cryptosporidium*
Secondary effluent	0	0	0
Microfiltration/Ultrafiltration (MF/UF)	0	4	4
RO	2	2	2
Ultraviolet (UV)/AOP	6	6	6
Free chlorine	6	1	0
Total	**14**	**13**	**12**
Target DPR Requirements	**15**	**13**	**13**

3.2.1 Treatment

The most obvious approach to control pathogen concentrations is through treatment, and the State Board is open to crediting any of the treatment processes in the DPR system, including the wastewater treatment plant (WWTP), the AWPF, and the drinking water treatment plant (WTP).

Wastewater Treatment. The role of the WWTP has shifted in the context of potable reuse. Whereas it has historically sought to make waters suitable for environmental discharge, it is now viewed as the first and critical barrier to creating a high-quality and consistent feedwater for the AWPF (Olivieri et al. 2016, Tchobanoglous et al. 2015). The State Expert Panel recommended that wastewater treatment facilities feeding DPR AWPFs provide both biological nutrient removal and tertiary filtration (Olivieri et al. 2016). Improvements to water quality may:

- provide greater degrees of pathogen reduction or inactivation
- decrease the concentration of organic compounds and constituents of emerging concern (CECs)
- improve the performance of downstream processes

The State Board previously awarded pathogen credits to WWTPs using performance values from the literature, though they have indicated that they will greatly reduce the default credits using this approach. Higher reduction credits can be sought if agencies perform site-specific monitoring studies. Given the expectation of higher pathogen LRV requirements for DPR, multiple agencies are currently pursuing pathogen studies to quantify and seek credit for pathogen removal through the wastewater treatment plant (Pecson 2018). As part of the State's DPR research effort, they have also developed consistent standard operating procedures (SOPs) for the collection and analysis of wastewater pathogen data (Pecson 2019).

Advanced Water Treatment. Many AWPF unit processes have established pathogen crediting frameworks that allow for V/G/C credits through both removal (e.g., membrane filters) and disinfection processes (e.g., chlorine, UV, and ozone). Importantly, these frameworks use the online monitoring of performance surrogates to ensure the continuous, high performance of the processes. The State Board has indicated that this high degree of monitoring will be critical for assessing the performance of treatment barriers in DPR settings.

Drinking Water Treatment. RWA projects include the WTP as an additional barrier downstream of the AWPF. While WTPs are typically designed to meet the 4/3/2 requirements of the Surface Water Treatment Rules, the State Board has indicated that project sponsors should not expect to receive those credits by default. This departure stems from the fact that they will require the WTP to be subject to the same rigorous crediting schemes that are used for AWPF crediting. Currently, many of the conventional physical removal processes—such as flocculation/sedimentation and granular media filtration—do not have such established frameworks. Those processes that do—including disinfection and membrane filtration—should be more straightforward for crediting. However, it is not clear at this time if differing WTP credits will be given to the same WTP if or when using a lower influent-purified-water-to-raw-surface-water ratio than when using a higher influent-purified-water-to-raw-surface-water ratio.

The IAP reiterated this point by stating that "some if not all current WTP LRV credits […] may be feasible but requires further investigation into proposed blending ratios and associated water quality entering the WTP," (Crook et al. 2020). While treatability studies will likely be required by DDW to validate the log reduction achieved at the WTP, the IAP encouraged Valley Water to "not […] accept the need to do full re-crediting of these facilities under certain circumstances," particularly considering lower influent-purified-water-to-raw-surface-water ratios (Crook et al. 2020).

3.2.2 Engineered Storage Buffers

The passage of treated effluent through a tank or another engineered storage buffer (ESB) provides an opportunity to a) mix the effluent with a larger volume of water and b) retain it for a period before releasing it into the downstream distribution system. **Mixing** can provide public health benefits during periods of off-spec water production or failure if the pulse of off-spec water combines with a larger volume of on-spec water in the tank. This mixing can lead to a decrease in the concentration of both pathogens and chemical contaminants in that pulse. **Retaining** the water in the tank provides time both to identify that an off-spec event has occurred and to enact a response to prevent that water from being distributed.

The amount of dilution that occurs depends both on the size of the reservoir and the duration of the off-spec event: a) the larger the reservoir, the greater the dilution, and b) the longer the off-spec pulse the lower the dilution. Figure 3-1 shows three different-sized ESBs—providing 4, 8, and 24 hours of hydraulic retention time (HRT)—and the degree of dilution during off-spec water events of increasing duration[3].

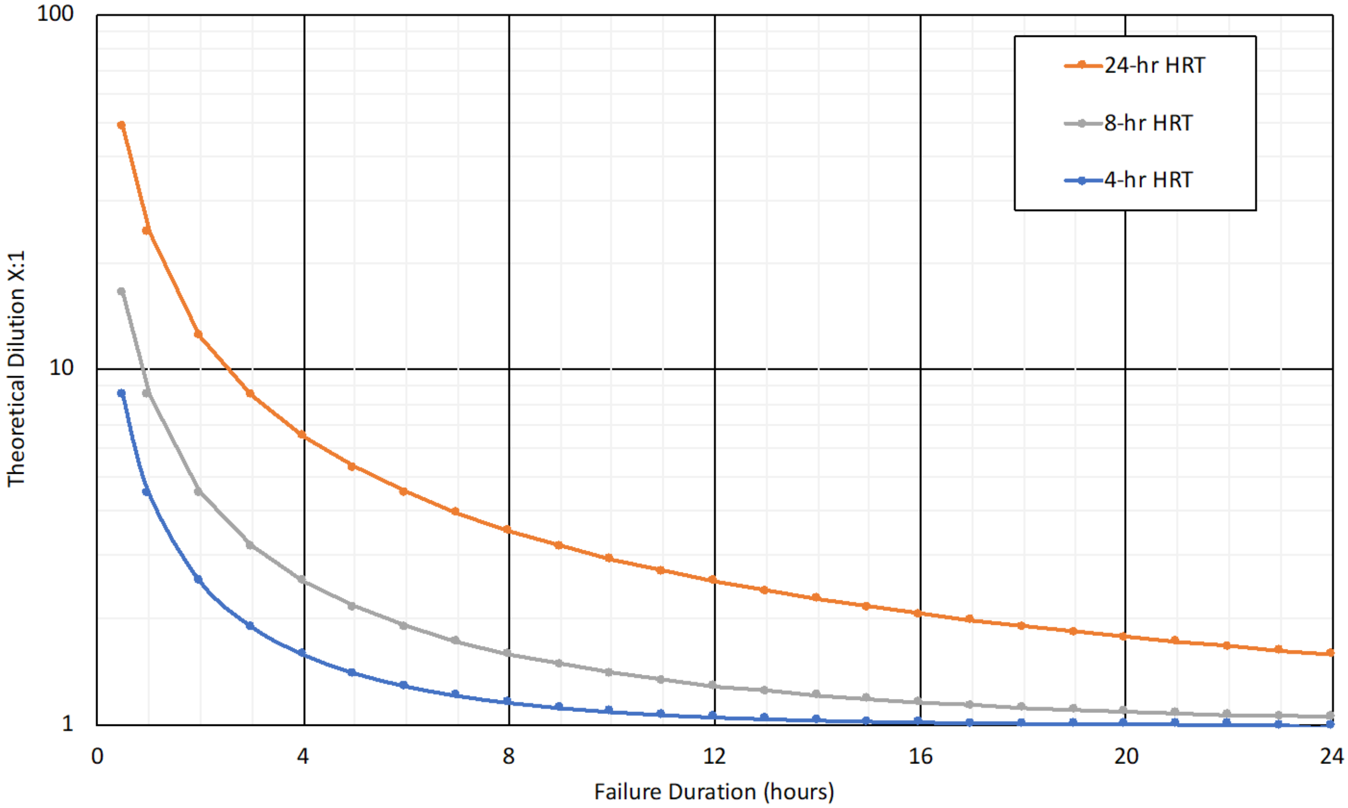

Figure 3-1. Dilution provided by a range of ESBs against off-spec water events. Results assume complete mixing in the storage tanks.

At what point should the dilution provided by a tank be considered significant or negligible? For pathogens, a 10-fold reduction (i.e., 1-log) could be used as the threshold for significance since control requirements are measured on a log scale. Figure 3-1 shows that 4- and 8-hour storage tanks would only meet this 10-fold threshold for failures lasting less than 15 minutes and 1 hour, respectively. A large, 24-hour storage tank would provide more protection but only for failures lasting up to 3 hours. ESBs are, therefore, unlikely to provide significant protection against pathogens unless the failures are of very short duration (< 1 hour).

Nevertheless, storage tanks can also provide retention time to respond to failure events. Unfortunately, designing a tank to maximize one of these benefits comes at the expense of the other. Tanks with ideal mixing characteristics (e.g., such as the CSTRs shown in Figure 3-1) maximize dilution but allow some of the pulse to pass immediately through the tank. Tanks that maximize retention time (e.g., plug flow reactors or PFR), however, provide minimal dilution. Therefore, trade-offs will be needed in the design of storage tanks and other ESBs. Based on this evaluation, the DPR storage facilities presented in the Master Plan seek to maximize retention time rather than mixing and dilution.

3.2.3 Blending

Blending—or the commingling of different flows—is another element of a potable reuse project that can be used to improve water quality in potable reuse settings. Blending advanced treated effluents with other source waters (e.g., surface or groundwaters) reduces the concentration of contaminants at a level equivalent to the blend ratio. To achieve a 1-log reduction of pathogens, however, assumes that advanced treated effluents make up only 10 percent of the total flow. While it is unlikely that such low blending ratios will be applied in DPR settings, this contaminant control strategy could be quantified and included in evaluations of public health protection.

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[3] To simplify the illustration, it is assumed that all storage tanks behave as continuously stirred tank reactors (CSTR)

3.3 Chemical Control

Environmental buffers also provide protection against toxic chemicals. Multiple mechanisms of attenuation occur in aquifers and reservoirs—including adsorption, photolysis, and biodegradation—whose benefits are being increasingly understood and quantified (Trussell 2018). Contaminant peaks have also been shown to be dampened as off-spec water travels, disperses, and mixes with other sources in the environment (Olivieri et al. 2016, Pecson et al. 2018). Eliminating the environmental buffer means that DPR systems will lose these chemical control benefits. As a result, the State Board is addressing two chemical research topics through its priority DPR research efforts: 1) the control of chemical peaks that enter potable reuse trains, and 2) unknown, low-molecular-weight compounds that may pass through the FAT train. These two topics are likely to be included in the future regulations to address chemical control in DPR.

3.3.1 Treatment

Decades of experience have shown that the FAT train provides excellent protection against nearly all categories of chemical compounds, including those with MCLs, NLs, and a wide selection of CECs. The process can also bring the bulk organics to very low levels that are typically below 100 micrograms per liter (μg/L) of TOC.

The compounds that remain are generally recalcitrant to the numerous treatment mechanisms included in the FAT train—size exclusion, charge exclusion, UV photolysis, and advanced oxidation. These compounds tend to be low-molecular-weight, uncharged compounds that are capable of passing through RO (Breitner et al. 2019). Acetone is a commonly cited example due to its repeated detection in the effluent of Orange County Water District's Groundwater Replenishment System, though other recalcitrant compounds—including aldehydes and trihalomethanes—have also been identified (Olivieri et al. 2016, Tackaert et al. 2019). The State Board has indicated that they will require additional chemical protection for DPR to further attenuate and dampen such peaks.

The State Board has not indicated what additional treatment will be needed to satisfy the chemical control requirements but is actively evaluating this topic in its DPR-4 Research Project (Debroux and Trussell 2019). Based on the lessons from 50+ years of groundwater recharge, one strategy for dealing with unknown contaminants is to increase the robustness of the treatment train (Pecson et al. 2015, Olivieri et al. 2016, SWRCB 2019b). The greater the diversity of removal mechanisms, the less likely it will be that a compound will not be addressed by at least one of the mechanisms. The following sections evaluate options that add robustness to the treatment train and address the new DPR chemical control goals.

O3/BAC. FAT pre-treatment with ozone and biological activated carbon (O3/BAC) increases treatment robustness by adding new mechanisms of control, including chemical oxidation, biodegradation, adsorption, and physical removal. By increasing robustness, O3/BAC pre-treatment provides additional protection against unknown contaminants.

It has also been shown to provide significant benefits in the control of chemical peaks. A recent study evaluated two treatment trains—the FAT train and an O3/BAC-FAT train—in their ability to control a set of low-molecular-weight, uncharged compounds (Tackaert et al. 2019). These four compounds—acetone, formaldehyde, N-nitrosodimethylamine (NDMA), and 1,4-dioxane—are known to be incompletely removed through the FAT train alone. In every case, O3/BAC provided protection beyond that provided by the FAT train (Figure 3-2). The O3/BAC-FAT train is being studied under the DPR-4 Research Project to evaluate its ability to provide control of chemical peaks in DPR settings (Debroux and Trussell 2019). By providing control against chemical peaks, \ unknown chemical contaminants, and pathogens, the O3/BAC-FAT treatment train has been identified as a candidate treatment train for DPR (Pecson et al. 2017, Olivieri et al. 2016).

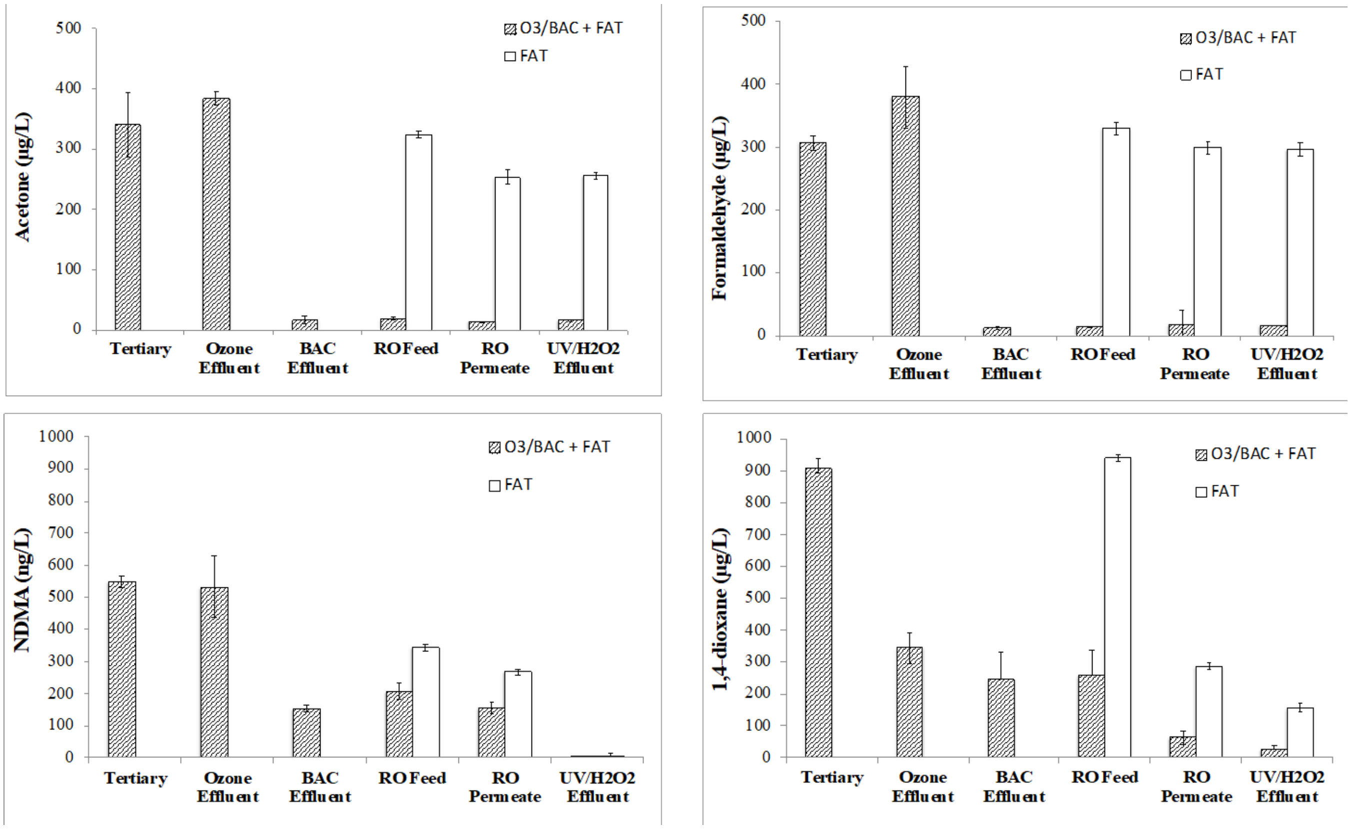

Figure 3-2. O_3/BAC pre-treatment provides additional protection against peaks of chemicals known to be incompletely removed by the FAT train

Courtesy of Tackaert et al. 2019

In addition to improving the quality of the treated effluent, O3/BAC pre-treatment can also improve the quality of the RO concentrate. It does this by breaking down, biodegrading, and removing organic compounds before the RO separates those compounds into the concentrate stream. One way to visualize the change in the organic make-up of the RO concentrate is through the use of excitation-emission matrices (EEM). With O3/BAC pre-treatment, both the RO feed and the concentrate have lower amounts of material that is observable in the EEM (Figure 3-3). This additional benefit of O3/BAC pre-treatment may allow for easier RO concentrate management and discharge, particularly with regard to the control of toxic organic compounds and CECs (Kenny, J. et al. 2018).

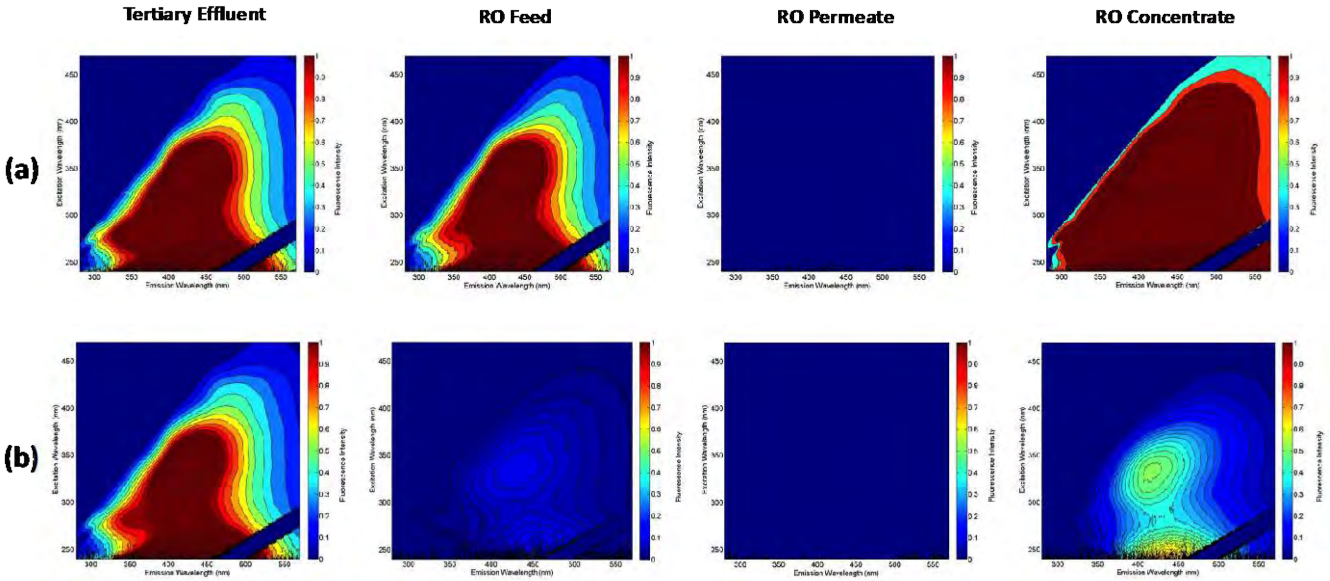

Figure 3-3. Excitation-emission matrices of AWPF membrane feed water, RO permeate, and RO concentrate (a) without O_3/BAC pre-treatment and (b) with O_3/BAC pre-treatment

Granular Activated Carbon. Another commonly cited option to enhance the robustness of the FAT treatment train is granular activated carbon (GAC). GAC is particularly effective at the adsorptive removal of uncharged, hydrophobic compounds, such as trichloroethylene (TCE) from contaminated sources. GAC provides limited protection, however, against many of the uncharged, polar compounds that are known to pass through the FAT train. Adsorption modeling was done to evaluate the ability of GAC to provide protection against two known toxic, low-molecular-weight compounds (NDMA and 1,4-dioxane) as well as two “sentinel” low-molecular-weight, polar compounds that have also been shown to pass through the FAT train (acetone and formaldehyde). The modeling assumed a standard design empty bed contact time (EBCT) of 15 minutes using Calgon F-400 GAC, and based the concentrations of the four polar, low-molecular-weight compounds on values used in Tackaert et al. (2019): NDMA at 550 ng/L, 1,4-dioxane at 10 µg/L, acetone at 2.7 mg/L, and formaldehyde at 307 µg/L. Removal of these compounds was compared against 150 µg/L of TCE, a groundwater contaminant often treated through GAC columns downstream of RO (Figure 3-4).

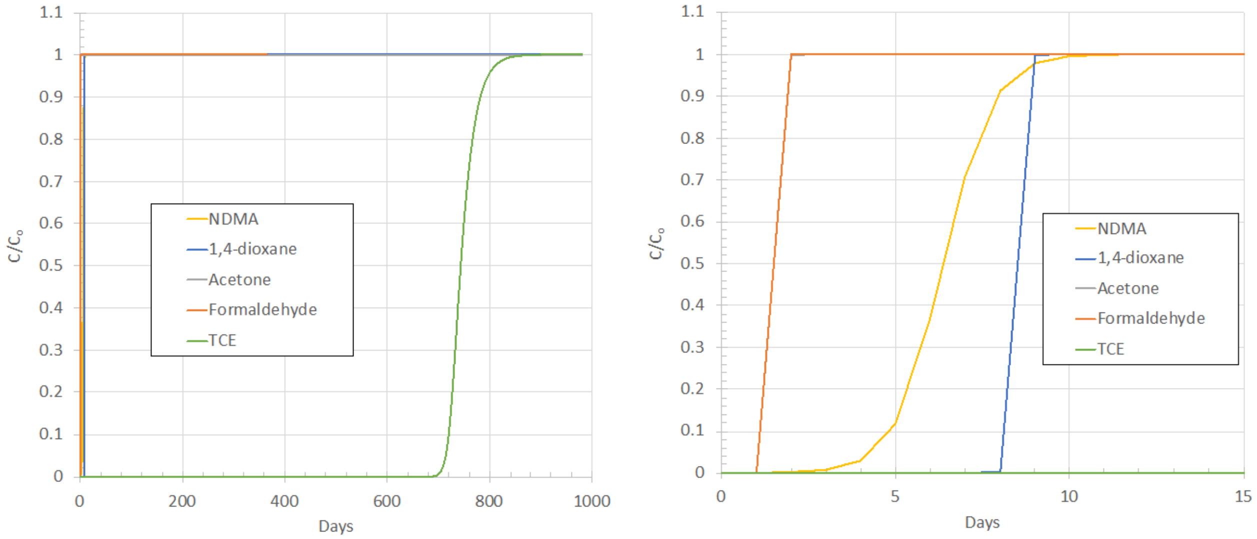

Figure 3-4. Modeling of GAC removal of TCE and four low molecular weight, polar compounds known to pass through the FAT train: NDMA, 1,4-dioxane, acetone, and formaldehyde

Left figure shows the GAC breakthrough curves for all compounds with the right figure focusing on breakthrough in the first 15 days.

The figure shows that the GAC columns could control a well-removed compound (TCE) for a period of approximately 800 days before needing replacement. This is a typical replacement frequency for GAC, which has proven to be an economically feasible approach for many groundwater applications. The polar compounds, however, exhaust the GAC and require replacement in as little as 2 to 10 days—a consequence of their poor adsorption onto activated carbon. This frequent rate of GAC change-out is infeasible from an operational and maintenance point of view and would also have a prohibitive economic impact.

In addition to looking at the removal of compounds that are consistently present, modeling was also undertaken to evaluate GAC's ability to attenuate chemical peaks. Modeling of a 12-h pulse of acetone at 10 mg/L (similar in magnitude and duration to the event described at OCWD's GWRS) showed only a 43 percent reduction through GAC, i.e., less than a 2-fold reduction of the peak height (Figure 3-5). Assuming chemical peaks may need to be attenuated up to 10-fold to provide meaningful protection, this example illustrates that GAC may have limited ability to attenuate the peaks of relevant low molecular weight compounds.

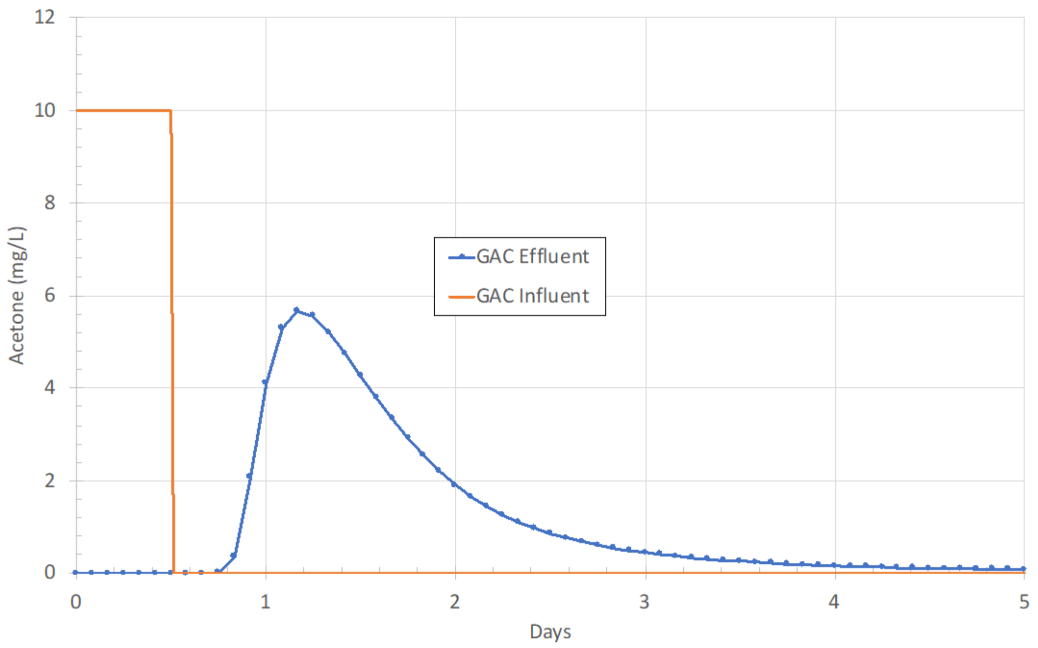

Figure 3-5. GAC provides limited reduction of a 10 mg/L pulse of acetone

(assuming 15-minute EBCT of Calgon F-400)

While GAC is effective at removing certain compounds, it will provide limited protection against the polar, low-molecular-weight compounds (both known and unknown) that are either consistently present in treated effluents or come through in peaks. Furthermore, GAC is strictly a chemical removal process that will not provide benefits in terms of pathogen credits.

Air stripping. Air stripping adds robustness to the FAT train by promoting the transfer of volatile organic compounds (VOC) from the aqueous to the gaseous phase. Their removal is a function of multiple factors, including the ratio of air to water, the hydraulic loading rate, temperature, and the volatility of the compound. Consequently, air stripping would have variable effectiveness against the types of compounds likely to persist through the FAT train, with greater effectiveness against more volatile compounds such as trihalomethanes (THM). Like GAC, air stripping would not provide additional control of pathogens and may allow for new contaminants to enter the treated water through exposure to the atmosphere. The growth of biological communities in the basins or towers may also require a downstream process (such as filtration or disinfection) to control the sloughing and release of microorganisms into the treated water.

3.3.2 Source Control

While treatment may be the primary means to control chemicals in DPR settings, management barriers including source control can also reduce the load and diversity of chemical compounds entering in the raw wastewater. The State Board has indicated that DPR source control programs will need to extend beyond both the National Pretreatment Program and the existing requirements from the IPR regulations (Figure 3-6). Reducing the input of chemicals into the system provides protection against chemical peaks, reduces the concentration of hard-to-treat or recalcitrant compounds, and offers another layer of protection against both known and unknown compounds.

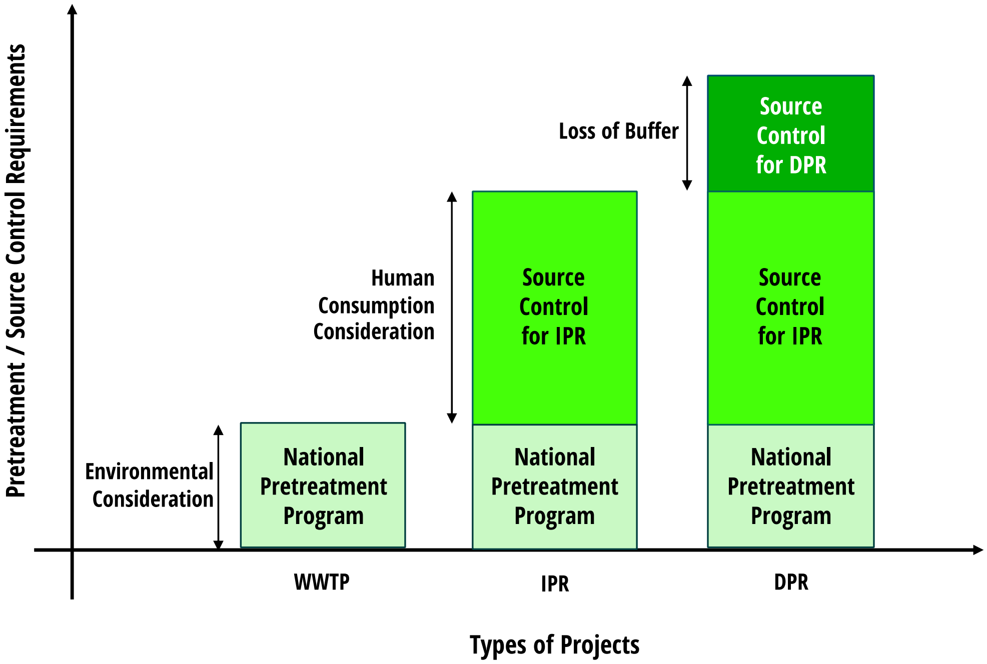
Pretreatment / Source Control Requirements
Environmental Consideration
Human Consumption Consideration
Loss of Buffer
National Pretreatment Program
National Pretreatment Program
National Pretreatment Program
Source Control for IPR
Source Control for IPR
Source Control for DPR
WWTP
IPR
DPR
Types of Projects

Figure 3-6. Source control for DPR may be stricter than IPR to account for the loss of the environmental buffer

3.3.3 Dilution and Blending

Section 3.2.2 described the benefits of dilution to control pathogens and highlighted the importance of storage tank size (i.e., HRT) in determining its benefits. Storage tanks with 4- to 8-hour HRTs can provide significant (i.e., 5- to 10-fold) reductions in contaminant concentrations, but only for short-duration failures of 1 to 2 hours. Whether this level of protection will be sufficient to satisfy the State Board's future requirements for chemical peak attenuation is not clear. Another RWA project being pursued in the State is the City of San Diego's Phase 2 Pure Water Project, which is evaluating the use of a reservoir that provides 30-day HRT. Given the large size of this reservoir compared to an engineered storage tank, significant degrees of dilution and chemical peak attenuation will be achieved. The City of San Diego is currently engaging the State Board to evaluate whether additional treatment beyond the reservoir is necessary to satisfy the chemical peak requirements. In addition to the reduction in contaminant concentrations, the passage of water through a storage tank or reservoir also provides time to respond to treatment issues and divert or further treat the water before distribution to consumers. Like dilution, blending can also be used to control both chemical peaks and unknown contaminants, but its benefits will be a function of the ratio of treated effluents to other water sources.

3.4 Failures and Response

Retention time is a key benefit in IPR projects because it provides an opportunity to address failures and other water quality excursions before they impact consumers. As long as the time to respond to issues is shorter than the retention time in the system, this approach is feasible. In DPR settings, however, there may be only hours of time between treatment and distribution—meaning DPR retention times will be orders of magnitude shorter than IPR (i.e., hours vs. months). DPR systems will need to compensate with new approaches to address this challenge since even rare, short-term failures significantly impact public health (Amoueyan 2017, Pecson 2017).

3.4.1 Failure Prevention

Many drinking water treatment plants prevent water from failing to meet requirements by providing a level of treatment beyond the minimum that is required. Common operational and design strategies used at drinking water treatment plants (including Valley Water's facilities) include:

- Use of concurrent disinfection processes: drinking water treatment plants may simultaneously use multiple forms of disinfection (e.g., chlorine and ozone) either of which alone would be sufficient to meet the minimum requirements. The failure of one system (including a complete unit process failure) would not cause the water to be off-spec since the redundant system is also in use.
- Use of disinfection "CT Ratio": drinking water treatment plants often operate with a disinfection CT (i.e., the product of the disinfectant residual "C" and the contact time "T") that is multiple times the minimum CT required. For example, if a permit required a CT of 5 mg-min/L, the operators may actually target a CT of 10 to 15 mg-min/L in order to have a CT ratio that is 2 to 3 times higher than the minimum.

The rationale for these two operational scenarios stems from the fact that potable water systems must continuously assure the quality of the water. By providing redundancy, the system can withstand excursions in treatment, monitoring, and operations without compromising the system's ability to produce acceptable water. A recent study demonstrated that an O_3/BAC-FAT treatment train provided sufficient redundancy in pathogen control to ensure a high degree of protection even in the face of process failures (Pecson 2017). The State Expert Panel also evaluated this treatment train and concurred that this level of protection should be sufficient for DPR (Olivieri et al 2016).

In addition to redundancy, treatment systems also benefit from multiple, different barriers (i.e., robustness) that provide more complete protection against the diversity of contaminants. Examples include the requirement for both filtration and disinfection under EPA's Surface Water Treatment Rules or the requirement for both UV photolysis and AOP for enhanced chemical control in the IPR regulations. Non-treatment barriers may also help prevent failures by reducing the load of contaminants entering a DPR system (i.e., source control), confirming that barriers are effective (i.e., monitoring), and improving water quality through dilution (i.e., storage tanks and reservoirs) and blending with other source waters.

3.4.2 Failure Response

Failure response relates to the identification of failures (either confirmed or presumed) and the triggering of actions to prevent the off-spec water from being distributed to consumers. Multiple elements are involved in failure response, including monitoring, control systems, diversions, and storage buffers that provide time to enact corrective actions. While failure prevention and failure response can be balanced in different proportions, this decision will impact the system's operational flexibility.

Systems with lower degrees of failure prevention (e.g., less treatment redundancy) may be required to compensate with higher degrees of automated system controls that divert off-spec water or shut down the system when performance is compromised. By having a narrower acceptable operational range, such systems may be impacted with lower levels of availability, a correspondingly higher unit cost of water, and more frequent interactions with regulators to reduce the probability of future off-spec events. Frequent failures may not only challenge the owner and regulators but also potentially damage public confidence in the water system.

A system with higher degrees of redundancy may not require the same level of automated responses, particularly if the system can demonstrate its resistance to failures (Pecson et al. 2017). Non-treatment barriers may also be effective at providing flexibility to deal with off-spec events. For example, a system with significant storage—such as a reservoir that provides multiple days or weeks of storage—may be able to operate with less strict automated responses since the reservoir provides time for operators to evaluate and respond to issues. This retention time allows for greater operational flexibility by delaying the entrance of water into the distribution system.

3.5 Technical, Managerial, and Financial Capacity

The 1996 federal Safe Drinking Water Act requires states to incorporate TMF capacity into public water system operations. In response to this requirement, California enacted Section 116540 of the Health and Safety Code, which states:

> *"No public water system that was not in existence on January 1, 1998, shall be granted a permit unless the system demonstrates to the DDW that the water supplier possesses adequate financial, managerial and technical capability to assure the delivery of pure, wholesome, and potable drinking water. This section shall also apply to any change of ownership of a public water system that occurs after January 1, 1998."*

DDW has expressed that the TMF requirements for DPR will be more restrictive than the TMF requirements for IPR. In its Proposed Framework for Regulating Potable Reuse, DDW states the following regarding TMF:

> *"The technical, managerial, and financial capacity required to build, maintain, monitor, and operate a potable reuse project increases with the complexity and sophistication of the system required. The complexity and sophistication are a function of the number and types of treatment processes, monitoring methods, and control points. These increase as the type of potable reuse goes from IPR to DPR." (SWRCB 2019b)*

For potable reuse projects, it is imperative that public water systems have sufficient TMF capacity to reliably operate and maintain the project. This is particularly important in DPR settings due to the loss of the environmental buffer and greatly reduced response times. Public systems pursuing DPR will need to have sound TMF capacity from source control all the way to the consumer to ensure public health protection at all times.

3.6 Aesthetics

Beyond addressing public health requirements, FAT trains also produce aesthetic, high-quality effluents that are low in color, turbidity, and odor. They are typically also treated to match the mineral content of existing source waters to create a water that is compatible with the drinking water distribution system and does not provoke colored water events. The temperature of purified water is frequently multiple degrees Celsius warmer than conventional drinking water sources. In IPR, this difference is mitigated by the fact that purified water spends significant time in the environment and frequently blends with other waters to match ambient temperatures. One new challenge for DPR will be to ensure that the temperature of the water is acceptable from an aesthetics standpoint (SWRCB 2019b, Tchobanoglous et al. 2015).

3.7 Summary of Public Health Considerations for RWA and TWA

Based on the known and anticipated considerations for DPR (both RWA and TWA) described above, the rubric shown in Table 3-2 has been developed to evaluate and score the portfolios. The scoring has been adjusted to account for the fact that there is neither regulatory certainty nor precedents for DPR in California. Like the other rubrics, each category is divided in terms of color—light blue, medium blue, and dark blue—to indicate the anticipated relative ease or difficulty of permitting with regard to each topic. More detailed, portfolio-specific discussion provided in Section 6.1.

Table 3-2. Rubric for evaluating public health criteria in RWA and TWA portfolios

	Pathogens	Chemicals	Source Control
○	≥ 15/13/13	High-quality WW to FAT train with enhanced robustness and multiple additional barriers	
◒	< 15/13/13	High-quality WW to FAT train with enhanced robustness and moderate additional barriers	Source control program likely to meet the enhanced requirements specified in future DPR regulations
●		DPR train with less robustness or more challenging source water or fewer barriers	Includes challenging source waters that require source control measurements beyond minimum future requirements

	Monitoring and Control	Retention and Response Time	TMF Capacity
○		≥ 24 hours retention prior to distribution (e.g., reservoir, clearwell)	
◒	Enhanced control system with multiple additional barriers (treatment, blending, retention)	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell)	Agencies with more AWPF experience and existing interagency agreements
●	Enhanced control system with moderate number of additional barriers	< 8 hours retention prior to distribution (e.g., reservoir, clearwell)	Agencies with less AWPF experience or lacking formalized interagency agreements
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Pathogens. Based on the discussion above, a "light blue" ranking was assigned to projects providing redundancy beyond the anticipated minimum requirements for DPR (15/13/13). A 2-log redundancy was used to distinguish the "light blue" category. "Medium blue" was assigned for projects providing minimal to no redundancy above the 15/13/13 benchmark, and "dark blue" for projects providing less than the benchmark.

Chemicals. Portfolios were assigned "light blue" rankings for systems that include enhanced robustness in the treatment train along with multiple additional barriers, such as enhanced source control, high-quality wastewater treatment with nutrient removal and filtration, dilution, and mixing in a reservoir or ESB. Portfolios providing multiple barriers were assumed to provide a high degree of protection against both unknown chemicals and chemical peaks. "Medium blue" and "dark blue" rankings were assigned to similar systems, but with increasingly lower numbers of control barriers or less treatment robustness.

Source control. As discussed in Section 3.3.2, the State Board has indicated that DPR source control programs will need to extend beyond the existing requirements for IPR. The findings and recommendations from the State's DPR source control panel have not been released, but preliminary strategies include enhanced monitoring of collection systems for volatile organic compounds, segregation of challenging waste streams, more frequent analysis of chemicals to include for control using local limits, and diversion at the AWPF to reroute purified water during periods when chemical peaks are detected at the facility. Given the uncertainty in the future requirements for the enhancements needed for DPR source control programs and the lack of additional direction from DDW during the June 9, 2020 meeting, the "light blue" scoring was not developed for DPR. The "medium blue" scoring was assigned for most projects under the assumption that they would be able to make the necessary enhancements to meet the stringent, future source control requirements. "Dark blue" was assigned if the project uses a challenging source water that might trigger source control measurements beyond the minimum future requirements.

Monitoring and control. One key difference in the DPR scenarios is the step-change reduction in response time: from the months provided in IPR scenarios to the hours available in the three DPR scenarios. One technical topic of interest is, therefore, demonstrating the capacity to rapidly integrate performance data and respond to failures in the short available retention times. DPR systems will also have to include rapid responses to any failures (presumed and confirmed) based on on-going performance evaluation, with the stringency of this requirement tied to the amount of retention time in the system. This topic represents one of the biggest technical challenges to DPR implementation. The lack of a "light blue" ranking for this category reflects this fact. The reliance on the control system is also dependent on the degree of additional barriers present. "Medium blue" was assigned to portfolios providing multiple additional barriers (e.g., treatment, blending, retention time) in addition to the monitoring and control system. "Dark blue" was assigned to portfolios with a moderate to low degree of additional barriers.

Retention and response time. While SWA systems must provide minimum theoretical retention times of more than 60 days in the reservoir, they are also required to show that the reservoir provides at least 100:1 or 10:1 dilution of any 24-hour pulse of off-spec water. In essence, the SWA regulations imply that all failures and excursions that may impact water quality will be detected and addressed with a 24-hour window. Building off of this precedent, DPR systems also providing 24 hours or more of retention time were assigned a "light blue" ranking. "Medium blue" was assigned to projects providing no less than 8 hours of retention time, and "dark blue" for < 8 hours. The amount of retention time required will be highly dependent on the effectiveness of DPR monitoring and control systems, with the "medium blue" and "dark blue" criteria requiring adjustment once it is better understood how much time is needed to detect and respond to failures in DPR scenarios.

TMF capacity. Because DPR requires the highest degree of complexity and sophistication, the State Board has indicated that it will have the strictest TMF requirements for RWA and TWA. DDW has highlighted the importance of this topic by stating that TMF capacity may be used to pre-qualify agencies seeking to pursue DPR projects. DDW has signaled that interagency coordination will be of greater importance for DPR to ensure the effectiveness of elements that span across agencies. Examples of heightened coordination include the need for enhancements to source control programs and potential future requirements for the optimization of wastewater treatment plants feeding DPR AWPFs. Agreements specifying these roles and responsibilities may be of greater importance than in IPR settings. Given the uncertainty in TMF requirements, "medium blue" is assigned the highest ranking and corresponds to the involvement of agencies with greater AWPF experience (technical capacity), lower numbers of agencies (less management complexity), and existing interagency agreements (greater management certainty). "Dark blue" is assigned to projects involving multiple agencies, those with less experience and/or resources, or projects that have not formalized binding agreements between agencies.

Having developed the rubrics to evaluate GWR, SWA, and DPR in the previous two sections, the following three sections evaluate each of the potable reuse portfolios in terms of their relative ease or difficulty in achieving regulatory compliance.

Section 4: Groundwater Recharge Portfolios

The GWR portfolios evaluated in the Countywide Master Plan cover a range of options that use multiple supply sources, multiple potential AWPFs, and varying design capacities and yields (Table 4-1). Nevertheless, they have many similarities with regard to advanced treatment facilities and delivery points. All of the GWR portfolios evaluated in this regulatory TM use a FAT-based treatment train (Figure 4-1) to produce a purified effluent for surface spreading at the LGRP. In the following sections, the four portfolios are evaluated based on their ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2).

Table 4-1. Key Attributes of the Four Groundwater Recharge Portfolios

GWR Portfolio	Design Capacity (mgd)	Annual Production (AFY)	AWPF Location	Source Supply
Portfolio 1a	24 mgd	24,000	Adjacent to Silicon Valley Advanced Water Purification Center (SVAWPC)	SJ/SC RWF
Portfolio 2a	24.5 mgd	17,300-23,000	Regional facility at former Los Altos Treatment Plant	PA RWQCP and Sunnyvale WPCP
Portfolio 2a	24.5 mgd	17,300-23,000	Regional facility at Sunnyvale	PA RWQCP and Sunnyvale WPCP
Portfolio 4	14 mgd at Palo Alto; 10.5 mgd at Sunnyvale	17,300-23,000	AWPFs at former Los Altos Treatment Plant and Sunnyvale	PA RWQCP and Sunnyvale WPCP

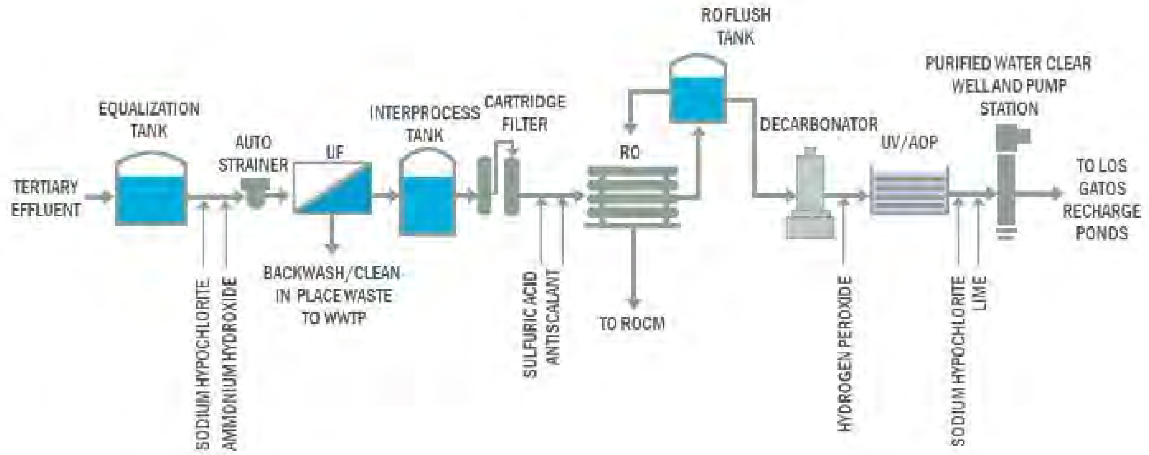

Figure 4-1. Proposed AWPF treatment train for the groundwater recharge portfolios

4.1 Public Health Criteria

4.1.1 Pathogens

The treatment train for the GWR portfolios (1a, 2a, 2b, and 4) provides a high degree of pathogen log reduction that exceeds the minimum 12/10/10 log reduction values for GWR (Section 2.1.1). The anticipated pathogen reduction credits are presented in Table 4-2. One benefit of surface spreading projects is that they can receive credit for the full 10-log reduction requirement for both *Giardia* and *Cryptosporidium* if the purified water is retained for 6 or more months in the aquifer. Consequently, the GWR portfolios provide significant pathogen redundancy, since both the FAT treatment and the aquifer alone meet or exceed the *Giardia* and *Cryptosporidium* requirements. Multiple GWR projects that use the FAT train do not recharge via surface spreading, but via subsurface injection. From a pathogen control perspective, the GWR portfolios in the Master Plan would also have a straightforward permitting approach for subsurface injection, providing a high degree of permitting flexibility to move from spreading to injection in the future. Given the high degree of treatment provided both at the AWPF and the environment, all the GWR portfolios meet the “light blue” category for pathogen control (Table 4-3).

Table 4-2. Pathogen Reduction Credits Expected for GWR Portfolios 1a, 2a, 2b, and 4

Unit Process	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment	0.4	0.2	0
MF	0	4	4
RO[a]	1.5	1.5	1.5
UV-AOP	6	6	6
Underground Retention[b]	6	10[c]	10[c]
Total	13.9	21.7	21.5
Required	12	10	10

a. Assumes use of standard RO surrogates for pathogen crediting (e.g., conductivity, TOC).

b. Groundwater modeling results show purified water introduced at LGRP is retained for at least one year before reaching potable supply wells (D7 Table 2-6). Table assumes 6 months of retention time is credited for the LGRP portfolios.

c. 10-log reduction credits for Giardia and Cryptosporidium apply for surface spreading projects that provide 6 or more months of retention time in the aquifer

Table 4-3. Regulatory Considerations for Pathogen Control in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	12/10/10 with ≥ 6 months of retention time ○	12/10/10 with ≥ 6 months of retention time ○	12/10/10 with ≥ 6 months of retention time ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

4.1.2 Chemicals

The GWR regulations contain chemical control requirements for all of the regulated drinking water constituents, along with a suite of unregulated compounds (Section 2.1). Based on the documented performance of FAT treatment trains to control chemical contaminants in GWR settings, along with site-specific performance data from the SVAWPC (Valley Water 2016), it is anticipated that the future GWR portfolios will be able to comply with the chemical control requirements for GWR (Table 4-4).

Table 4-4. Regulatory Considerations for Chemical Control in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	FAT with no challenging source water ○	FAT with no challenging source water ○	FAT with no challenging source water ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Periodically, the State Board updates the monitoring requirements in consultation with their Science Advisory Panel for CECs. Most recently, the Recycled Water Policy was updated to include requirements for the use of bioassays to provide non-targeted monitoring against groups of chemical compounds (SWRCB 2019c). Based on preliminary data, the FAT train should achieve a water quality that complies with the additional monitoring requirements. Data from the State's current bioassay monitoring phase should be available in the next one or two years. RO treatment is also effective at controlling the recently regulated perfluorinated compounds (PFOA and PFOS) down to acceptably low concentrations.

4.1.3 Source Control

A source control program will be required for all of the potable reuse portfolios and must comply with the requirements outlined in Section 2.1.1. Unlike the previous two criteria (pathogen and chemical control), important differences may exist between the GWR portfolios that warrant site-specific evaluations. The following sections describe the three approaches associated with Portfolios 1a, 2a/2b, and 4.

4.1.3.1 Portfolio 1a

The City of San José, on behalf of the SJ/SC RWF, a joint powers authority, currently administers an industrial pretreatment and pollutant source control program that complies with the requirements of the National Pretreatment Program mandated under the Clean Water Act. The existing source control program will need to be expanded to further protect recycled water sources intended for GWR. This new effort would target contaminants of public health concern for potable applications, including chemicals with MCLs, public health goals (PHGs), NLs, and other Department- and Board-specified chemicals. Through this effort, the City would be required to enhance the source control program to:

- investigate the fate of these chemicals through the wastewater and recycled water facility
- investigate and monitor the source of the chemicals
- mitigate discharge of the chemicals through enforcement of commercial/industrial discharge and through public outreach for residential discharge
- maintain an inventory of chemicals discharged into the collections system

It is assumed that the City of San José would continue to administer the source control program for Portfolio 1a. Implementing an expanded source control program for Portfolio 1a is facilitated by the fact that an existing program is in place and is completely within the jurisdiction of a single project partner. Furthermore, source control programs have been established for many GWR projects providing greater regulatory clarity. Based on this evaluation, Portfolio 1a falls into the "light blue" category (low difficulty) for source control. During discussions with DDW on June 9, 2020, it was confirmed that DDW will not require that a formal interagency agreement be in place that defines the roles and responsibilities related to source control. While such an agreement falls outside of DDW's regulatory requirements, such agreements will be beneficial to manage the project and ensure that the partners comply with their respective responsibilities.

4.1.3.2 Portfolios 2a and 2b

While the requirements for source control are equivalent to Portfolio 1a, Portfolios 2a and 2b present new challenges due to the fact that wastewater from two agencies will be supplying a single feed to the regional AWPF. This unique scenario will require the coordination of two existing source control programs, a situation that has not yet arisen in California's GWR projects. The regulations state that recycled water used for GWR projects "shall be from a wastewater agency" that administers an industrial pretreatment and pollutant source control program. This uncertainty was discussed with the regulators during the June 9, 2020 meeting. Based on preliminary feedback from DDW and the Regional Board, they did not see any immediate hurdles to the presence of two separate source control programs continuing to operate in parallel. While the regulations describe a single agency overseeing the source control program, they would likely not require that the two programs be united under a single agency's umbrella. By maintaining the two existing programs independently, a new interagency agreement would not be required to unite the programs. Based on this feedback, Portfolios 2a and 2b present no additional challenges compared to Portfolio 1, leading them to fall into the "light blue" category (low difficulty) for source control.

4.1.3.3 Portfolio 4

Portfolio 4 also includes two wastewater agencies though each agency would feed its own AWPF. One unique aspect of this portfolio is that the purified effluents from the two facilities would be blended and delivered to the LGRP for percolation. Based on preliminary feedback from DDW and the Regional Board, this portfolio—like Portfolios 2a and 2b—would not trigger additional regulatory hurdles since the existing source control programs could continue to operate in parallel. Consequently, Portfolio 4 is also assigned the "light blue" category for source control.

4.1.3.4 Source Control Summary and Next Steps

A summary of the regulatory challenges associated source control for the four GWR portfolios is presented in Table 4-5.

Table 4-5. Regulatory considerations for Source Control in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	Source control program meets the enhanced requirements specified in IPR regulations ○	Source control program meets the enhanced requirements specified in IPR regulations ○	Source control program meets the enhanced requirements specified in IPR regulations ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

4.1.4 Monitoring and Control

As described above, the stringency of monitoring and control will be a function of the degree of response time provided by the system. In all of the GWR scenarios, significant aquifer retention times (> 6 months) are available, meaning that these projects should be able to use the precedents established at existing GWR projects. Portfolios 1a, 2a, and 2b are evaluated separately to account for the fact that Portfolio 4 includes two AWPFs that may require additional coordination in monitoring and control.

4.1.4.1 Portfolios 1a and 2a/2b

The industry has extensive experience with the monitoring and control of GWR systems, including frameworks for demonstrating the effectiveness of critical control points for pathogenic microorganisms and chemical contaminants. Well-developed surrogate frameworks provide high-frequency confirmation of the performance of pathogen control barriers, with control systems designed to respond to deviations in performance and water quality. Since the 2009 update to the GWR regulations, GWR projects have been required to submit monthly reports on performance. This delay in the integration and reporting of performance data has been acceptable in GWR due to the long period of retention time provided by the environmental buffer. This delay may not be acceptable, however, for more direct forms of potable reuse, as will be discussed later.

Given the extensive industry experience with the monitoring and control of GWR systems, particularly those with extensive (> 6 month) retention times, Portfolios 1a, 2a, and 2b fall into the "light blue" category (low difficulty) for monitoring and control.

4.1.4.2 Portfolio 4

Portfolio 4 represents a unique scenario in California GWR projects with two separate AWPFs combining effluents for GWR. The monitoring and control requirements at the two facilities could be higher if DDW requires operational coordination between the two AWPFs. However, based on interaction with DDW during the June 9, 2020 meeting, they stated that they would not likely impose new requirements for inter-facility communication. Each AWPF could operate independently, with monitoring requirements largely restricted to each individual facility. Based on this feedback, Portfolio 4 also falls into the "light blue" category.

4.1.4.3 Monitoring and Control Summary and Next Steps

An overview of the monitoring and control requirements for the GWR portfolios is provided in Table 4-6.

Table 4-6. Regulatory Considerations for Monitoring and control in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	Proven with many precedents Less stringent with longer retention times ○	Proven with many precedents Less stringent with longer retention times ○	Proven with many precedents Less stringent with longer retention times ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

4.1.5 Retention and Response Time

The numeric modeling results for recharge at the LGRP shows that underground retention time is at least 2 years (Todd Groundwater 2017). Correcting that value in line with the GWR regulations requires multiplying the modeled retention time by a factor of 0.5, meaning that the system would actually be credited for 12 months of retention time. While the regulations require no less than two months of aquifer retention time, most of the existing projects provide 6 months to years of retention time. Generally, DDW will use greater scrutiny of GWR projects whenever retention times drop below the 6-month threshold (Chang 2013, Pecson 2015). Because the anticipated retention time exceeds the 6-month threshold for all portfolios, they fall into the "light blue" category (low difficulty) for retention and response time (Table 4-7).

Table 4-7. Regulatory Considerations for Retention and Response Time in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	≥ 6 months in the aquifer ○	≥ 6 months in the aquifer ○	≥ 6 months in the aquifer ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

4.1.6 TMF Capacity

As described in Section 3.5, DDW will require that agencies pursuing GWR possess the technical and managerial capacity to build, maintain, monitor, and operate potable reuse projects. The technical and managerial requirements increase with the complexity and sophistication of the system, which may be assessed based on the number and types of processes, monitoring methods, and the number of control points. Furthermore, DDW has stated that they will look at the existence of agreements between partner agencies that establish their roles and responsibilities during their evaluation of TMF. Such agreements demonstrate managerial capacity and the ability to ensure system reliability from source control and wastewater treatment through treatment at the AWPF and distribution.

Valley Water—who will oversee the operations and maintenance of the AWPFs—is a large agency with significant experience in advanced treatment. DDW has stated that additional efforts to demonstrate technical capacity—such as the use of a GWR demonstration project—would not be required assuming that the portfolios fall within the standard conditions of the regulation. Interagency agreements that define the roles and responsibilities of the partners, however, have not yet been completed. Consequently, the portfolios have been assigned a preliminary ranking in the “medium blue” category to account for this uncertainty (Table 4-8).

Table 4 8. Regulatory Considerations for TMF in the Groundwater Recharge Portfolios

Portfolio:	1a	2a/2b	4
	Agencies lacking formalized interagency agreements ◒	Agencies lacking formalized interagency agreements ◒	Agencies lacking formalized interagency agreements ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Recommended next steps for TMF include:

- **Continuing to engage partners on interagency agreements**: Based on feedback from DDW during the June 9, 2020 meeting and the IAP Report (Crook et al. 2020), agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during DDW’s assessment of TMF. The existence of such agreements may provide further evidence of the project’s ability to ensure the reliability of the potable reuse system. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for system upgrades and maintenance.

- **Further assessment of TMF capabilities among the portfolios:** The IAP recommended that additional TMF capability criteria be developed to facilitate a comparison of TMF capability among the portfolios. Additional evaluation criteria such as availability of source water, funding ability, willingness of agency partners to collaborate, and status of interagency agreements were recommended by the IAP. The IAP also highlighted the importance of finalizing interagency agreements, as no project is feasible without shared understanding among participating partner agencies.

4.2 Environmental Compliance Criteria

Two discharge types for the GWR portfolios (1a, 2a, 2b, and 4) must be compliant with all applicable environmental regulations: ROC discharge and AWPF product water releases. The following sections describe the regulations and key considerations related to implementing the different GWR portfolios.

4.2.1 Reverse Osmosis Concentrate Management

The primary approach for ROC management for all portfolios involves the discharge of ROC into South SF Bay. The exception to this is the SWA portfolio, where the AWPF is located at Morgan Hill. For additional information regarding ROC management strategies, refer to Section 9 of this TM.

4.2.2 Product Water Release

All of the GWR portfolios involve the release of AWPF product water into LGRP with percolation into the Santa Clara Subbasin. LGRP and the subbasin have designated beneficial uses in the SF Bay Basin Plan, meaning that a number of environmental regulations will apply to protect the existing quality of these waters. Additionally, water that percolates into the Santa Clara Subbasin must also meet the requirements specified in the SNMP. The following subsections describe the key aspects of the applicable environmental regulations that may impact AWPF product water release compliance.

4.2.2.1 SF Bay Basin Plan

The LGRP and the Santa Clara Subbasin have a number of beneficial uses defined in the SF Bay Basin Plan (Table 4-9).

Table 4-9. SF Bay Basin Plan Beneficial Uses for Los Gatos Recharge Ponds and Santa Clara Subbasin

Los Gatos Recharge Ponds (Campbell Percolation Ponds)	Santa Clara Subbasin
GWR	MUN
Commercial and sport fishing (COMM)	Industrial process water supply (PROC)
Cold freshwater habitat (COLD)	Industrial service water supply (IND)
Fish spawning (SPWN)	Agricultural water supply (AGR)
Warm freshwater habitat (WARM)	
Wildlife habitat (WILD)	
Water contact recreation (REC-1)	
Non-contact recreation (REC-2)	

The beneficial uses for both waters span human consumptive (MUN, GWR and COMM), industrial (PROC, IND), agricultural (AGR), aquatic life (COLD, SPWN, WARM), wildlife, and recreation uses. The SF Bay Basin Plan defines numeric and narrative water quality objectives to ensure that the defined beneficial uses are protected. The applicable water quality objectives per the SF Bay Basin Plan are different for surface waters and groundwater, and the following sections summarize these objectives and describe considerations that may impact the AWPF product water release.

4.2.2.1.1 Water Quality Objectives for Los Gatos Recharge Ponds

The beneficial uses for LGRP include protections for aquatic life and recreation but do not specify municipal uses for the water. Communication with the Regional Board to confirm these defined beneficial uses and associated water quality objectives will be an important part of future permitting efforts. For this initial assessment, this section describes the applicable water quality objectives to protect aquatic life habitat and recreation per the current-defined beneficial uses.

Narrative water quality objectives are included in the SF Bay Basin plan for bioaccumulation, biostimulatory substances, color, floating material, oil and grease, population and community ecology, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and toxicity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses. Table 4-10 provides a summary of the numeric water quality objectives that are applicable to Los Gatos Recharge Ponds.

Table 4-10. Summary of Numeric Water Quality Objectives for the Los Gatos Recharge Ponds

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Fecal Coliform	MPN/100 mL	Geometric mean < 200 90th Percentile < 400	Water Contact Recreation (REC-1)
Total Coliform	MPN/100 mL	Median < 240 No Sample > 10,000	Water Contact Recreation (REC-1)
Enterococcus	MPN/100 mL	Geometric mean < 35 No Sample > 104	Water Contact Recreation (REC-1)
Dissolved Oxygen	mg/L	≥ 7.0[b]	Cold water habitat (COLD)
pH	--	6.0 – 8.5[c]	Applicable to all surface waters in the SF Bay Basin Plan
Temperature	°F (°C)	Change from natural receiving water temperature ≤ 5 (2.8)	Applicable to all surface waters in the SF Bay Basin Plan
Turbidity	NTU	< 10% change for waters with natural turbidity > 50 NTU	Applicable to all surface waters in the SF Bay Basin Plan
Un-ionized Ammonia	mg/L	Receiving Water Concentrations: Annual Median = < 0.025 mg/L Maximum = 0.4 mg/L	Median applicable to all surface waters in the SF Bay Basin Plan, maximum applicable to water bodies in the Lower Bay
Chemical Constituents	--	See Table 3.4 in the SF Bay Basin Plan	Applicable to all surface waters in the SF Bay Basin Plan.

a. Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.

b. The median dissolved oxygen concentration for any three consecutive months shall not be less than 80% of the dissolved oxygen content at saturation.

c. pH changes greater than 0.5 in ambient pH levels shall not be allowed

As shown in Table 4-10, the applicable water quality objectives for LGRP protect the habitat for aquatic life and recreational uses. Of these constituents, many are expected to be met through the proposed FAT at the AWPF, including the requirements for bacteria, dissolved oxygen, pH, turbidity, and additional chemical constituents regulated in Table 3.4 of the SF Bay Basin Plan.

Many of the constituents with water quality objectives are also regulated in the Title 22 criteria for the protection of public health. For these constituents, compliance will likely be straightforward because all of the proposed GWR portfolios include FAT, which produces a very high-quality effluent. The two remaining constituents in Table 4-10, temperature and un-ionized ammonia, require additional consideration and may need treatment and management strategies that go beyond what is required for Title 22 compliance to address and comply with these water quality objectives. For example, full oxidation of any ammonia in the AWPF may be required prior to delivery to LGRP that could be achieved with reliable nitrification in the water reclamation facility prior to the AWPF as well as with a sufficient dose (and contact time) of sodium hypochlorite in the pipeline between the AWPF and the ponds. Regarding temperature, additional studies and monitoring of the LGRP may be required to better understand the potential impact of the AWPF product water.

If it is found that significant treatment or management strategies are needed to comply with these water quality objectives, communication with the Regional Board regarding proposed strategies for compliance would be beneficial. The defined beneficial uses of the LGRP as well as the benefits of a new drinking water supply for the region will be assessed to ultimately determine the permitting approach for the selected portfolio. With regular communication with the Regional Board, negotiations regarding applicable water quality objectives may help to lower the compliance burden.

4.2.2.1.2 Water Quality Objectives for Santa Clara Subbasin

Narrative and numeric water quality objectives are also specified in the SF Bay Basin Plan to protect groundwater beneficial uses. These objectives are summarized in Table 4-11.

Table 4-11. Summary of Numeric Water Quality Objectives for the Santa Clara Subbasin

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Total Coliform	MPN/100 mL	7-day median < 1.1	Municipal Supply (MUN)
Organic and Inorganic Chemical Constituents	--	MCLs and sMCLs apply Additionally objectives may apply at the discretion of the Regional Board	Municipal Supply (MUN)
Radioactivity	--	The drinking water MCLs for radioactive constituents apply	Municipal Supply (MUN)
Taste and Odor	--	The drinking water MCLs apply	Municipal Supply (MUN)

a. *Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.*

As shown in Table 4-11, the water quality objectives that are applicable to the Santa Clara Subbasin are focused on the protection of public health because this groundwater basin is designated a MUN. Compliance with these targets should be straightforward based on the fact that the Title 22 requirements are either equal to or more stringent than those specified in the SF Bay Basin Plan. The FAT train proposed for all of the GWR portfolios would provide significant treatment barriers that result in a high-quality AWPF product water. Due to this high degree of treatment, all portfolios are anticipated to comply with the requirements of the SF Bay Basin Plan related to protecting the Santa Clara Subbasin.

4.2.2.2 Salt and Nutrient Management Plan

Valley Water manages the Santa Clara Subbasin and led the development of the SNMP for the region with engagement from multiple stakeholders. The SNMP included extensive review and analysis of current and projected future groundwater quality to ensure that the existing water quality of the subbasin can be maintained as recycled water projects expand in the region. Through development of the SNMP, the current and projected future subbasin water quality was evaluated, as well as the potential assimilation capacity for salt and nutrient loading in the area. Through this work, it was determined that the water quality objectives established in the SF Bay Basin Plan for TDS, nitrate (as NO_3), and nitrate + nitrite (as N) could be adopted for the SNMP objectives to protect the Santa Clara Subbasin. Table 4-12 summarizes the objectives.

Table 4-12. Numeric Water Quality Objectives of the Santa Clara Subbasin SNMP

Parameter	Unit	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)
TDS	mg/L	500	10,000
Nitrate	mg/L as NO3	45	--
Nitrate and nitrite	mg/L as N	10	30

LGRP allow water to percolate into the Santa Clara Subbasin, and so the water quality objectives presented in Table 4-12 apply. Again, because all of the proposed GWR portfolios include FAT, this level of treatment will ensure that the water quality objectives for TDS, nitrate, and nitrite will be met with no additional considerations beyond what is required to protect public health. Therefore, all portfolios are anticipated to comply with the requirements of the Santa Clara Subbasin SNMP due to the high level of treatment provided by the FAT train.

4.2.2.3 California Toxics Rule

For delivery to LGRP, the AWPF product water will likely be required to comply with the CTR. The CTR establishes statewide water quality standards for inland surface waters, enclosed bays, and estuaries to protect aquatic ecosystems and human health. The rule was promulgated in 2000 by the United States Environmental Protection Agency (USEPA) as “Water Quality Standards; Establishment of Numeric Criteria for Priority Pollutants for the State of California” and updated in 2001. The numeric water quality objectives established by the CTR apply to specific categories, including freshwater habitats, saltwater habitats, and human health for the consumption of either water and organisms or organisms only. For all waters that do not include a municipal and domestic water supply beneficial use, the objectives from the ‘organisms only’ human health consumption category apply. These water quality objectives are applicable to water released into LGRP and must be met at the end of the discharge pipe unless a mixing zone is authorized by the Regional Board.

Many of the constituents with applicable water quality objectives in the CTR are also MCLs and sMCLs, which must be met per the Title 22 requirements for GWR projects. For these constituents, it is expected that the AWPF product water release into Los Gatos Recharge Ponds will be compliant with the CTR. Some of the constituents regulated by the CTR include water quality objectives that are lower than or in addition to Title 22 requirements. Furthermore, some constituents are grouped differently, such as THMs, where the MCL is a sum of four individual THMs but the CTR includes water quality objectives for three of the individual THMs—bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform[4].

Many of the water quality objectives in the CTR are easily met through the extensive treatment at the AWPF. Exceptions include constituents that can persist through FAT (both RO and UV/AOP), such as the DBPs

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[4] The water quality objectives in the CTR for BDCM, DBCM, and bromoform (organisms only, because there is not a MUN beneficial use) are 46 µg/L, 34 µg/L, and 3360 µg/L, respectively. A limit for chloroform was not promulgated in the CTR, and instead the EPA reserved the decision on stating numeric criteria. Per the CTR, “EPA intends to reassess the human health 304(a) criteria recommendation for chloroform. For these reasons, EPA has decided to reserve a decision on numeric criteria for chloroform in the CTR and not promulgate water quality criteria as proposed.

BDCM, DBCM, and NDMA[5]. The CTR water quality objectives for these constituents at the LGRP fall under the 'organisms only' category, which is applicable because it is not designated a municipal supply. Under this designation, the water quality objective (WQO) concentrations are less stringent than the levels that should be met for all the GWR portfolios. Nevertheless, compliance with the CTR for these constituents should be considered during future phases of the design. Communication with the Regional Board may provide clarity regarding what WQOs must be met, and the preferred approach for compliance and future permitting efforts.

4.2.2.4 Anti-Degradation Policy

As described in Appendix B2 – Regulatory Framework, the State of California's policy on antidegradation is set forth in State Board Resolution 68-16[6], which establishes the following policy that requires maintenance of high-quality waters:

> *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water and will not result in water quality less than that prescribed in the policies.*

The State of California antidegradation policy (which preceded the 1972 Clean Water Act and federal antidegradation regulations) may apply to LGRP, which would require that its existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed GWR project outweigh the detriments. By complying with the SF Bay Basin Plan and CTR and based on the expected high quality of the AWPF product water release, it is anticipated that it will comply with the Anti-Degradation Policy by meeting all of the public health requirements for this project.

4.2.2.5 Chlorine Residuals Requirements

As described in Appendix B2 – Regulatory Framework, draft statewide chlorine standards currently being considered by the State Board would require that dischargers reduce the chlorine residual in water released to receiving waters to as close to zero as practicable.[7] Pending approval of statewide standards for chlorine residual in discharges, the State Board (2014) has implemented the EPA chlorine residual criteria in the current statewide NPDES permit governing discharges to surface waters from drinking water systems.[8] The EPA has established national criteria[9] for chlorine residual concentrations to protect freshwater aquatic life, including:

- CMC (1-hour) = 19 µg/L
- CCC (4-day) = 11 µg/L

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[5] Although NDMA is effectively removed through UV/AOP, reformation can occur during product water conveyance if a chloramine residual is maintained.

[6] Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Waters in California was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.

[7] State Water Resources Control Board (State Board). Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California. 2006.

[8] State Water Resources Control Board (State Board). Order WQ 2014-0194-DWQ, General Order CAG140001, Statewide NPDES Permit for Drinking Water System Discharges to Waters of the United States. 2014.

[9] U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.

Because the criteria are lower than the sensitivity of many chlorine analyzers, non-detect values from a chlorine meter are typically sufficient to satisfy the chlorine residual requirements. The need for dechlorination of the product water prior to delivery to LGRP should be discussed with the Regional Board.

4.2.2.6 Summary of Product Water Release Compliance

Based on the considerations described in the previous subsections, the relative complexity of complying with the applicable environmental requirements for each GWR portfolio is summarized in Table 4-13. Portfolios 1a, 2a, and 2b have the same relative complexity because each option involves the same approach for AWPF product water release. The SF Bay Basin Plan and CTR include some constituents that are not regulated under the Title 22 requirements and may therefore require additional investigation into whether other treatment and/or management barriers are needed. However, it is expected that future phases of the design process can address these considerations, and so Portfolios 1a, 2a, and 2b are shaded light blue for SF Bay Basin Plan and CTR compliance.

Table 4-13. Summary of AWPF product water release regulatory complexity for each GWR portfolio

Consideration	Portfolio 1a	Portfolio 2a	Portfolio 2b	Portfolio 4
SF Bay Basin Plan	Some constituents (e.g., temperature and un-ionized ammonia) may require additional treatment and/or management barriers for compliance			Same considerations as other portfolios but added complexity due to two AWPFs
California Toxics Rule	The high-quality FAT product water is anticipated to meet these requirements			Same considerations as other portfolios but added complexity due to two AWPFs
SNMP	The high-quality FAT product water meets these requirements			
Anti-Degradation Policy	The high-quality FAT product water meets these requirements			
Chlorine Residuals Requirements	Provisions can be included to quench chlorine residuals prior to environmental release			

Portfolio 4 is expected to be more complicated when showing compliance with the SF Bay Basin Plan and CTR because two separate AWPFs will be discharging to LGRP, which may double the permitting and compliance reporting effort. For example, the Regional Board may require two separate permits for the effluents from each AWPF and may require sampling of the combined effluents in addition to the product water from each AWPF. However, because high-quality effluent will be produced at both AWPFs and are both expected to comply with the applicable requirements, Portfolio 4 was shaded light blue for all of the environmental permitting considerations. It is important to note that communication with the Regional Board regarding applicable water quality objectives and the desired approach for complying with the regulations may help to clarify the required permitting and compliance reporting effort for this portfolio. For all portfolios, compliance with the SNMP, anti-degradation policy, and chlorine residuals requirements should be achieved without additional considerations beyond the requirements for public health protection (shaded light blue).

4.3 Summary of GWR Portfolios

4.3.1 Public Health Summary and Next Steps

A summary of the overall rankings for the four GWR portfolios is presented in Table 4-14. Based on the preliminary analysis and subsequent discussion with DDW on June 9, 2020, there were not significant differences between the GWR portfolios in terms of regulatory complexity. All of the portfolios fall mainly into the “light blue” category, which reflects the extensive experience with GWR in California.

Table 4-14. Summary of public health regulatory considerations for the groundwater recharge portfolios

Portfolio:	1a	2a/2b	4
Pathogens	12/10/10 with ≥ 6 months of retention time ○	12/10/10 with ≥ 6 months of retention time ○	12/10/10 with ≥ 6 months of retention time ○
Chemicals	FAT with no challenging source water ○	FAT with no challenging source water ○	FAT with no challenging source water ○
Source Control	Source control program meets the enhanced requirements specified in IPR regulations ○	Source control program meets the enhanced requirements specified in IPR regulations ○	Source control program meets the enhanced requirements specified in IPR regulations ○
Monitoring and Control	Proven with many precedents Less stringent with longer retention times ○	Proven with many precedents Less stringent with longer retention times ○	Proven with many precedents Less stringent with longer retention times ○
Retention and Response Time	≥ 6 months in the aquifer ○	≥ 6 months in the aquifer ○	≥ 6 months in the aquifer ○
TMF	Agencies lacking formalized interagency agreements ◒	Agencies lacking formalized interagency agreements ◒	Agencies lacking formalized interagency agreements ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Of the six criteria, only the TMF category received a "medium blue" ranking. Efforts that could be undertaken to address this issue, i.e., to shift the rankings toward "light blue," include:

- **Continuing to engage partners on interagency agreements**: Based on feedback from DDW, agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during assessments of TMF. The existence of such agreements may provide further evidence of the project's ability to ensure the reliability of the potable reuse system. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for upgrades and maintenance of the system.

4.3.2 Environmental Compliance Summary and Next Steps

A summary of the overall rankings for the four GWR portfolios with regard to environmental compliance is presented in Table 4-15. In general, the portfolios are anticipated to follow existing precedents to show compliance with the product water release requirements. Consequently, most of the GWR portfolios receive "light blue" rankings for product water release. It is possible that Portfolio 4 may have increased monitoring complexity due to the presence of two AWPFs, though this may not be sufficient to increase its rankings to "medium blue." The degree to which this will impact the portfolio should be discussed with the Regional Board at a future regulator meeting. Strategies to address any challenges with this set up should also be discussed to help guide future efforts by Valley Water and its partners.

Table 4-15. Summary of Environmental Regulatory Considerations for the Groundwater Recharge Portfolios			
Portfolio:	1a	2a/2b	4
SF Basin Plan	○	○	○
California Toxics Rule	○	○	○
SNMP	○	○	○
Anti-degradation	○	○	○
Chlorine residual	○	○	○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Section 5: Surface Water Augmentation Portfolio

The SWA portfolio involves a Morgan Hill satellite treatment facility (including both wastewater treatment and an AWPF) to produce a purified effluent to recharge the Anderson Reservoir (see Table 5-1 and Figure 5-1). After retention in the reservoir, the water will be conveyed for surface water treatment at the Santa Teresa WTP. In the following sections, the SWA portfolio is evaluated based on its ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2).

Table 5-1. Key Attributes of the Morgan Hill Surface Water Augmentation Portfolios

SWA Portfolio	Design Capacity	AWPF Location	Source Supply
Morgan Hill SWA	2 mgd	Morgan Hill	Morgan Hill

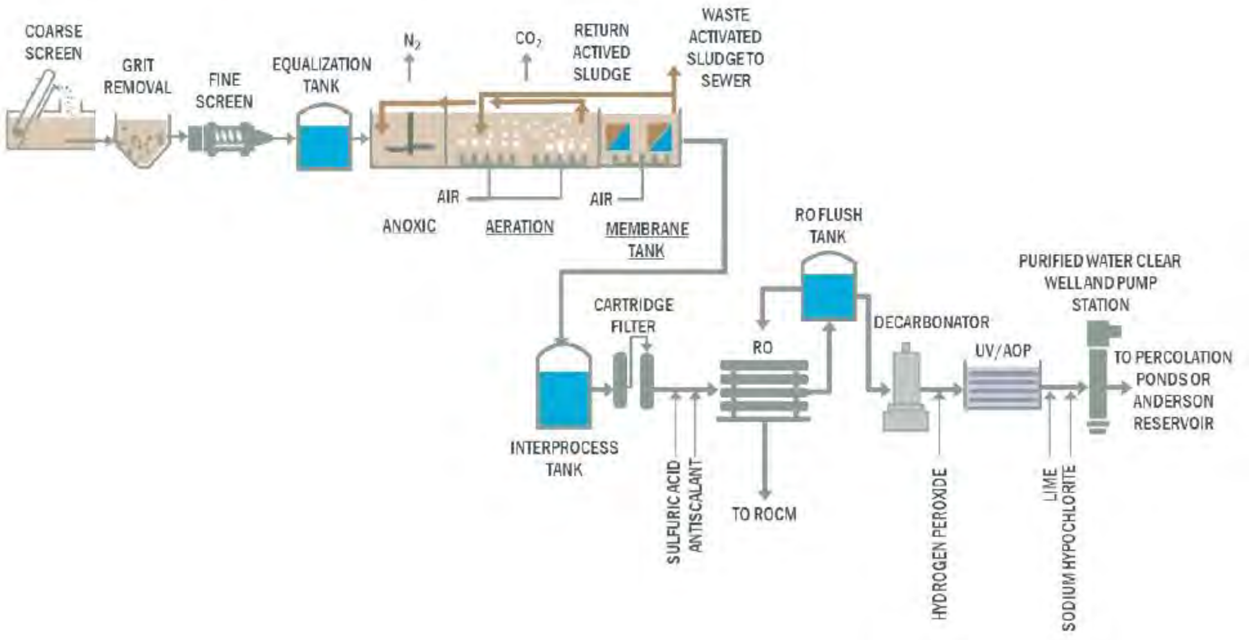

Figure 5-1. Morgan Hill satellite treatment facility process flow diagram

5.1 Public Health Criteria

5.1.1 Pathogens

The level of pathogen treatment in SWA is dependent on both the retention time and dilution provided by the reservoir (Section 2.1.2). The retention time is calculated as the volume of the reservoir divided by the total outflow of water from the reservoir. This total includes the outflow of purified water but also any other imported supply sources or runoff feeding the Anderson Reservoir. Based on an assumed operational capacity of 52,000 acre-feet (AF) for the Anderson Reservoir, the 180-day minimum retention time could be achieved as long as the outflow does not exceed 90 mgd. For the purposes of this memo, it is assumed that the Anderson Reservoir would provide no less than 180 days of retention time and no less than 100:1 dilution. Under these conditions, the AWPF treatment train would need to provide a minimum pathogen log reduction of 8/7/8. The SWA project would meet the AWPF requirements as well as the overall 12/10/10 requirements in conjunction with the Santa Teresa WTP (Table 5-2). It should be noted that the train also provides the flexibility to comply with the stricter 9/8/9 requirements for SWA projects that only provide a 10:1 minimum dilution (Section 2.1.1). Given the high degree of treatment provided at the and Anderson Reservoir, the SWA portfolio meets the “light blue” category for pathogen control (Table 5-3).

Table 5-2. Pathogen Reduction Credits Expected for the SWA portfolio

Unit Process	Virus	*Giardia*	*Cryptosporidium*
Membrane bioreactor (MBR)[a]	1.5	2	2
RO	2	2	2
UV-AOP	6	6	6
AWPF	9.5	10	10
Minimum AWPF requirements[b]	8	7	8
Santa Teresa WTP	4	3	2
Overall treatment provided	13.5	13	12
Minimum overall requirements[b]	12	10	10

a. *MBR LRV credits based on Australian WaterVal Tier 1 approach.*
b. *Assumes that the reservoir provides a minimum 180-day retention time and 100:1 dilution.*

Table 5-3. Regulatory Considerations for Pathogen Control in the Surface Water Augmentation Portfolio

Portfolio:	Morgan Hill SWA		
	12/10/10 with 6-month retention time and 100:1 dilution ○		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

5.1.2 Chemicals

From the perspective of public health requirements, both GWR and SWA have similar requirements for the control of toxic chemicals. Section 4.1.2 described the well-documented ability of the FAT train to protect against the large diversity of chemical compounds of concern for potable reuse applications. Given the similarity of the SWA treatment train to the GWR trains, the SWA portfolio meets the “light blue” category for chemical control (Table 5-4).

Table 5-4. Regulatory Considerations for Chemical Control in the Surface Water Augmentation Portfolio

Portfolio:	**Morgan Hill SWA**		
	FAT treatment with no challenging source water ○		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

5.1.3 Source Control

It is assumed that SCRWA would continue to administer the source control program for the SWA Portfolio. Implementing an expanded source control program for this portfolio is facilitated by the fact that an existing program is in place and is completely within the jurisdiction of a single project partner. Furthermore, source control programs have been established for other SWA projects providing greater regulatory clarity. Based on this evaluation, the SWA Portfolio falls into the “light blue” category (low difficulty) for source control assuming that the program would be enhanced to comply with the SWA requirements (Table 5-5). As discussed in Section 2.1, formal interagency agreements describing source control responsibilities are not required under the SWA regulation. The presence or absence of such agreements was not used to evaluate the SWA Portfolio from a regulatory point of view, though such agreements are likely to be important from an institutional perspective.

Table 5-5. Regulatory Considerations for Source Control in the Surface Water Augmentation Portfolio

Portfolio:	**Morgan Hill SWA**		
	Source control program meets the enhanced requirements specified in IPR regulations ○		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

5.1.4 Monitoring and Control

While the monitoring and control of the AWPF may be straightforward, the SWA portfolio involves augmenting a reservoir that is a source of feed water for the downstream Santa Teresa WTP. Any issues that impact the purified water’s compliance with the SWA regulations may therefore lead to consequences for the WTP, including the need to switch to alternative sources of water. The dependence of the facility on AWPF performance requires additional coordination and control between the AWPF, reservoir operations, and the downstream WTP in the form of a Joint Plan, as specified in Section 60320.301 of the SWA regulation. This project would benefit from the precedents set by the two San Diego region SWA projects, both of which augment reservoirs that are treated at a single downstream surface water treatment plant. While a formal Joint Plan is required by DDW, they expressed during the June 9, 2020 meeting that the requirements for monitoring and control would be similar for GWR. Given this feedback, the SWA project falls into the “light blue” category for monitoring and control (Table 5-6). Note that expanding the project to provide a source water for multiple end uses (e.g., multiple water treatment plants and/or groundwater recharge basins) will introduce greater complexity and may require a higher number of permits. Pursuing such a configuration may result in the project entering the “medium blue” category.

Table 5-6. Regulatory Considerations for Monitoring and Control in the Surface Water Augmentation Portfolio

Portfolio:	Morgan Hill SWA		
	Single agency overseeing WW/AWTF and DW with > 100:1 dilution at a single end use location ○		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

5.1.5 Retention and Response Time

As described in Section 5.1.1, it is assumed that the reservoir will provide greater than 180 days of theoretical retention time and no less than 100:1 dilution of a 24-hour pulse of off-spec water. This is based on the assumption that the reservoir will operate at its recent operational maximum volume of 52,000 AF and will not have outflows exceeding 90 mgd[10]. In meeting these theoretical retention time and dilution requirements, the project falls into the most conservative operational regime described by the regulation. Based on this evaluation, the SWA Portfolio falls into the “light blue” category (low difficulty) for retention and response time (Table 5-7).

Table 5-7. Regulatory Considerations for Retention and Response Time in the Surface Water Augmentation Portfolio

Portfolio:	Morgan Hill SWA		
	> 120-d of theoretical retention time in the reservoir ○		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

5.1.6 TMF Capacity

DDW will require that agencies pursuing SWA possess the TMF capacity to build, maintain, monitor, and operate potable reuse projects. The TMF requirements increase with the complexity and sophistication of the system, which may be assessed based on the number and types of processes, monitoring methods, and the number of control points. Based on preliminary feedback from DDW at the June 9, 2020 meeting, they do not believe that a demonstration facility would be necessary to support Valley Water’s TMF evaluation, assuming that the project is not proposing to include new elements that fall outside of the regulations. While this feedback is preliminary, it provides initial reassurance that SWA will not pose a significant additional hurdle for technical capacity than GWR.

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[10] Currently, the Anderson Reservoir is undergoing a seismic retrofit project to improve its reliability and safety while restoring the reservoir to its original capacity of 89,000 AF. Greater capacity will increase retention time and will likely increase dilution as well.

As with GWR, DDW will likely look at the existence of agreements between partner agencies during their evaluation of TMF to understand how the project will ensure reliability. At this time, interagency agreements that define the roles and responsibilities of the partners have not yet been completed. Consequently, the SWA portfolio has been assigned a preliminary ranking in the “medium blue” category to account for this (Table 5-8).

Table 5 8. Regulatory Considerations for TMF Capacity in the Surface Water Augmentation Portfolio

Portfolio:	Morgan Hill SWA		
	Agencies lacking formalized interagency agreements ◒		
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

To address the TMF requirements for this portfolio, the following next step is recommended:

- **Continue to engage partners on interagency agreements**: Based on feedback from DDW during the June 9, 2020 meeting, agreements that provide definition on the roles and responsibilities of the various agencies would be beneficial during DDW’s assessment of TMF. The existence of such agreements provides further evidence of the project’s ability to ensure the reliability of the potable reuse system. A major topic of interest for such agreements includes defining the requirements for enhanced source control programs. As noted in Section 4.1.6, the IAP stressed the importance of pursuing interagency agreements with project partners to define key components of the project such as availability of source water, funding ability, and willingness of agency partners to collaborate.

As stated in the Monitoring and Control discussion (Section 5.1.4), expanding the project to provide a source water for multiple end uses (e.g., multiple water treatment plants and/or groundwater recharge basins) will introduce greater complexity and require additional coordination and permitting. Pursuing this configuration may cause the project to enter the “dark blue” category.

5.2 Environmental Compliance Criteria

The proposed AWPF at Morgan Hill will produce a ROC and a purified water that must meet environmental requirements. The following subsections describe the approaches and regulatory considerations related to ROC management and product water release for the SWA portfolio.

5.2.1 RO Concentrate Management

The SWA portfolio involves an AWPF at Morgan Hill, with feedwater to the satellite wastewater facility sourced from the Morgan Hill trunk sewer. For additional information regarding ROC management strategies, refer to Section 9 of this TM.

5.2.2 Product Water Release

The proposed SWA portfolio involves the delivery of AWPF product water to Anderson Reservoir, which is currently used by Valley Water as a municipal drinking water source. Anderson Reservoir has designated beneficial uses in the SF Bay Basin Plan that include the full spectrum of use categories—human consumption, aquatic and wildlife habitat, and recreation. With these beneficial uses, a number of environmental regulations are applicable to preserve the defined uses. The following subsections describe the key aspects of the applicable environmental regulations that may impact AWPF product water release compliance.

It was noted in Section 2.2 that the IAP proposed an alternative permitting approach that would require the re-characterization of the AWPF product water as a new basic water supply instead of a waste discharge. If this strategy was pursued during future phases of project development, some of the environmental requirements described below may not be applicable. However, the two existing SWA projects in California have opted to approach permitting using the existing framework of characterizing the AWPF product water as a waste discharge. Therefore, these existing precedents may impact the feasibility of the IAP's proposed alternative permitting approach for this SWA portfolio. Due to the uncertainty regarding the IAP's strategy, this TM assessed compliance assuming the existing framework of characterizing the AWPF product water as a waste discharge.

5.2.2.1 SF Bay Basin Plan

Anderson Reservoir has the following designated uses per the SF Bay Basin Plan:

- MUN
- GWR
- COMM
- COLD
- SPWN
- WARM
- WILD
- REC-1
- REC-2

Beneficial uses related to human consumption and aquatic life have additional water quality objectives that are defined by the CTR. Because Anderson Reservoir is listed as a municipal and domestic supply, all of the water quality objectives associated with this use are applicable per the SF Bay Basin Plan and the CTR.

Narrative water quality objectives are included in the SF Bay Basin plan for bioaccumulation, biostimulatory substances, color, floating materials, oil and grease, population and community ecology, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, and toxicity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses. Table 5-9 provides a summary of the numeric water quality objectives that are applicable to Anderson Reservoir.

Table 5-9. Numeric Water Quality Objectives for Anderson Reservoir

Parameter	Unit	Most Stringent Applicable Limit[a]	Associated Beneficial Use
Fecal Coliform	MPN/100 mL	Geometric mean < 20	Municipal Supply (MUN)
Total Coliform	MPN/100 mL	Geometric mean < 100	Municipal Supply (MUN)
Enterococcus	MPN/100 mL	Geometric mean < 35 No Sample > 104	Water Contact Recreation (REC-1)[b]
Dissolved Oxygen	mg/L	≥ 7.0[c]	Cold water habitat (COLD)
pH	--	6.0 – 8.5[d]	Applicable to all surface waters in the SF Bay Basin Plan
Radioactivity	mg/L	The drinking water MCLs for radioactive constituents apply	Municipal Supply (MUN)
Temperature	˚F (˚ C)	Change from natural receiving water temperature ≤ 5 (2.8)	Applicable to all surface waters in the SF Bay Basin Plan
Turbidity	NTU	< 10% change for waters with natural turbidity > 50 NTU	Applicable to all surface waters in the SF Bay Basin Plan
Un-ionized Ammonia	mg/L	Receiving Water Concentrations: Annual Median = < 0.025 mg/L Maximum = 0.4 mg/L	Median applicable to all surface waters in the SF Bay Basin Plan, maximum applicable to water bodies in the Lower Bay
Chemical Constituents	--	See Tables 3.4 and 3.5 in the SF Bay Basin Plan The drinking water MCLs and sMCLs apply	Applicable to all surface waters in the SF Bay Basin Plan. MCLs and sMCLs apply to Municipal Supply (MUN) beneficial use

a. *Various beneficial uses may require different water quality objectives. This table shows the most stringent requirement that must be met per the SF Bay Basin Plan.*

b. *Although water contact recreation is not allowed in Anderson Reservoir, the SF Bay Basin Plan notes that the associated water quality objectives still apply.*

c. *The median dissolved oxygen concentration for any three consecutive months shall not be less than 80 percent of the dissolved oxygen content at saturation.*

d. *pH changes greater than 0.5 in ambient pH levels shall not be allowed*

Many constituents with applicable water quality objectives in the SF Bay Basin Plan are also regulated via the Title 22 requirements for SWA projects. For these constituents, the SF Bay Basin Plan water quality objectives will be met with the level of treatment and management needed to protect public health. These constituents include radioactivity, turbidity, MCLs, and sMCLs. Additionally, the SF Bay Basin Plan requirements for other constituents will be met by meeting the Title 22 requirements, including for bacteria and pH.

Some constituents have stricter water quality objectives per the SF Bay Basin Plan, including some metals, dissolved oxygen, temperature, and un-ionized ammonia. For these constituents, an assessment of the anticipated AWPF product water quality and the ability to comply with these additional requirements will be needed. In general, many constituents will be effectively removed by the treatment train proposed for this

SWA portfolio. Ozone followed by BAC will provide an initial organics barrier, and RO followed by UV/AOP will reduce many of the remaining constituents of concern. This treatment train will provide a strong barrier against metals, and so compliance with the additional water quality objectives for metals is anticipated without the need for additional treatment. Considering dissolved oxygen, the unit processes will both remove organics and introduce dissolved oxygen into the product stream. It is anticipated that this water quality objective will be met without additional treatment. Similarly, free chlorine will be used in the pipeline between the AWPF and Anderson Reservoir, which will oxidize any remaining ammonia in the water; thus, compliance with the un-ionized ammonia water quality objective is anticipated with the current AWPF design. Finally, although the temperature of the AWPF water will likely be warmer than Anderson Reservoir, the significant amount of dilution provided in the reservoir is anticipated to be sufficient for meeting the temperature water quality objective. Nevertheless, the temperature impact may need to be confirmed through future hydrodynamic modeling.

Although it is anticipated that all applicable water quality objectives will be met with the proposed AWPF treatment train, monitoring and reporting of the reservoir conditions before and after AWPF product water is introduced will still be required per Title 22 requirements and the SF Bay Basin Plan. Additionally, confirmation from the Regional Board regarding applicable water quality objectives would provide clear guidance for future permitting efforts.

5.2.2.2 California Toxics Rule

The CTR will likely be applicable for delivery of AWPF product water to Anderson Reservoir. The water will be subject to the water quality standards defined in the CTR, which must be met at the end of the discharge pipe unless a mixing zone is authorized by the Regional Board. Unlike the GWR portfolios that release AWPF product water into LGRP, the drinking water reservoir has a designated beneficial use of municipal and domestic supply. Because of this designation, the water quality objectives in the CTR for human health and consumption of both water and organisms apply.

Many of the constituents included in the CTR are already regulated per the Title 22 regulations for SWA; however, some constituents have stricter requirements per the CTR. The constituents of highest concern for achieving compliance with the CTR due to their persistence through FAT (both RO and UV/AOP) are the THMs BDCM and DBCM, and NDMA. BDCM and DBCM are disinfection byproducts that can form when naturally occurring organic matter and bromide (i.e., organic and inorganic precursors) in the water react with free chlorine during disinfection. In drinking water, THMs are regulated under the Disinfection Byproducts Rules by the sum of chloroform, BDCM, DBCM, and bromoform known as total trihalomethanes (TTHM). The MCL for TTHM is 80 µg/L. Under the CTR, THMs are regulated individually, with unique numerical criteria for each compound. The CTR limits for BDCM and DBCM are 0.56 µg/L and 0.41 µg/L, i.e., approximately two orders of magnitude lower than the MCL. Similarly, CTR limits for NDMA are 0.069 ng/L, more than two orders of magnitude lower than the NL of 10 ng/L.

Due to these significantly stricter requirements, additional treatment and/or management barriers may be required to comply with the water quality objectives. Strategies employed by the two San Diego region SWA projects to control these chemicals could be leveraged to minimize DBP formation. It may also be beneficial to discuss the requirements with the Regional Board to confirm what water quality objectives are applicable and to develop potential strategies and permitting approaches that can ensure compliance.

5.2.2.3 Anti-Degradation Policy

Similar to the GWR portfolios, the Anti-Degradation Policy applies to Anderson Reservoir, and requires that its existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed SWA project outweigh the detriments. Based on the expected high quality of the AWPF product water, it is anticipated that it will comply with the Anti-Degradation Policy by meeting all of the environmental and public health requirements for this project.

5.2.2.4 Chlorine Residuals Requirements

Similar to the GWR portfolios, release to Anderson Reservoir would be required to comply with the EPA's established chlorine residuals requirements. Although the proposed treatment includes free chlorine disinfection of the AWPF product water, a dechlorination facility can be provided to dose sodium bisulfite to ensure that the product water is dechlorinated prior to release into Anderson Reservoir.

5.2.2.5 Summary of Product Water Release Compliance

The environmental regulations applicable to the AWPF product water release for the SWA Portfolio were discussed in this section. To summarize the relative difficulty of complying with each applicable environmental regulation, Table 5-10 includes color-coded shading, where light blue indicates no additional analysis or treatment is anticipated to comply and medium blue denotes the potential for additional work being needed to ensure compliance. As described in the previous sub-sections, the majority of the relevant requirements and water quality objectives will be met with the proposed AWPF treatment train. Only the CTR may impose treatment requirements that would require additional consideration that should be addressed in future permitting efforts. To address the potential compliance challenges associated with the CTR, discussions with the Regional Board may provide guidance for future steps in the permitting effort and help to better define what will be required for future implementation of this portfolio.

Table 5-10. Summary of AWPF Product Water Release Regulatory Complexity for the SWA portfolio

Consideration	Morgan Hill SWA
SF Bay Basin Plan	The high-quality AWPF product water meets these requirements
California Toxics Rule	Some WQOs are more restrictive than public health requirements and may require additional considerations for compliance
Anti-Degradation Policy	The high-quality AWPF product water meets these requirements
Chlorine Residuals Requirements	Provisions can be included to quench chlorine residuals prior to release

5.3 Summary of SWA Portfolio

5.3.1 Public Health Summary and Next Steps

A summary of the overall rankings for the SWA portfolio is presented in Table 5-11. The SWA portfolio falls primarily into the "light blue" category to reflect the fact that it is pursuing the conservative end of the SWA regulations and following a similar approach to the San Diego region SWA projects. Nevertheless, this project would be one of the first five projects to pursue SWA in California, which adds a layer of uncertainty compared to the GWR projects.

Table 5-11. Summary of Public Health Regulatory Considerations for the Surface Water Augmentation Portfolio

Portfolio:	Morgan Hill SWA
Pathogens	12/10/10 with 6 month retention time and 100:1 dilution ○
Chemicals	FAT treatment with no challenging source water ○
Source Control	Source control program meets the enhanced requirements specified in IPR regulations ○
Monitoring and Control	Single agency overseeing WW/AWTF and DW with > 100:1 dilution at a single end use location ○
Retention and Response Time	> 120-d of theoretical retention time in the reservoir ○
TMF	Agencies lacking formalized interagency agreements ◒

Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Topics of interest for future efforts include:

- **Monitoring and control**: Continue to develop the operational scenarios for the SWA project to understand if purified water from the Anderson Reservoir will be sent to other locations in addition to Santa Teresa WTP. This scenario will increase the complexity of the system—including modifications to the Joint Plan—and may present additional challenges. Per DDW feedback at the June 9, 2020 meeting, these challenges would not be insurmountable, but should be included in the evaluation of regulatory compliance.
- **Continue to engage partners on interagency agreements**: Securing interagency agreements can provide further evidence of the project's ability to ensure the reliability of the potable reuse system. One recent example of a governance structure created to support a regional potable reuse project is the joint powers authority (JPA) that was formed between Padre Dam Municipal Water District, the City of El Cajon, and the County of San Diego in support of the ECAWP project. The JPA creates a new public agency with the authority to plan for, design, construct, own, lease, operate, maintain, repair, and replace the ECAWP project; receive, convey, treat, and dispose of wastewater; produce and deliver product water and Title 22 water; and perform services or assume obligations of the Member Agencies and non-Member Agencies specifically related to the ECAWP project.

5.3.2 Environmental Compliance Summary and Next Steps

A summary of the overall rankings for the SWA portfolio with regard to environmental compliance is presented in Table 5-12. Based on the permitting experience of San Diego's North City Pure Water project, the product water release requirements should be largely straightforward. Given the municipal designation of the Anderson Reservoir, there are certain constituents that will have stricter environmental discharge requirements than those present on the public health side. This is particularly true for a number of DBPs, including DBCM, DCBM, and NDMA. Discussions with the Regional Board are recommended to confirm that these low targets must be met, and to discuss options for achieving compliance either through dilution crediting or treatment.

Table 5-12. Summary of Environmental Compliance Regulatory Considerations for the SWA Portfolio

Portfolio:	Morgan Hill SWA		
SF Basin Plan	○		
California Toxics Rule	◒		
SNMP	○		
Anti-degradation	○		
Chlorine residual	○		
Legend:	○ *least complex*	◓ *medium complexity*	● *most complex*

Section 6: Raw and Treated Water Augmentation Portfolios

6.1 Public Health Criteria

The DPR portfolios include both RWA and TWA options that use the same wastewater supplies as the GWR options to supply feedwaters to the AWPFs. All of the DPR portfolios build off the FAT train used for GWR but include enhancements to address the DPR considerations described in Section 3. The process flow diagrams for the RWA and TWA trains are show on Figures 6-1 and 6-2. The design capacities and yields of the portfolios are shown in Table 6-1.

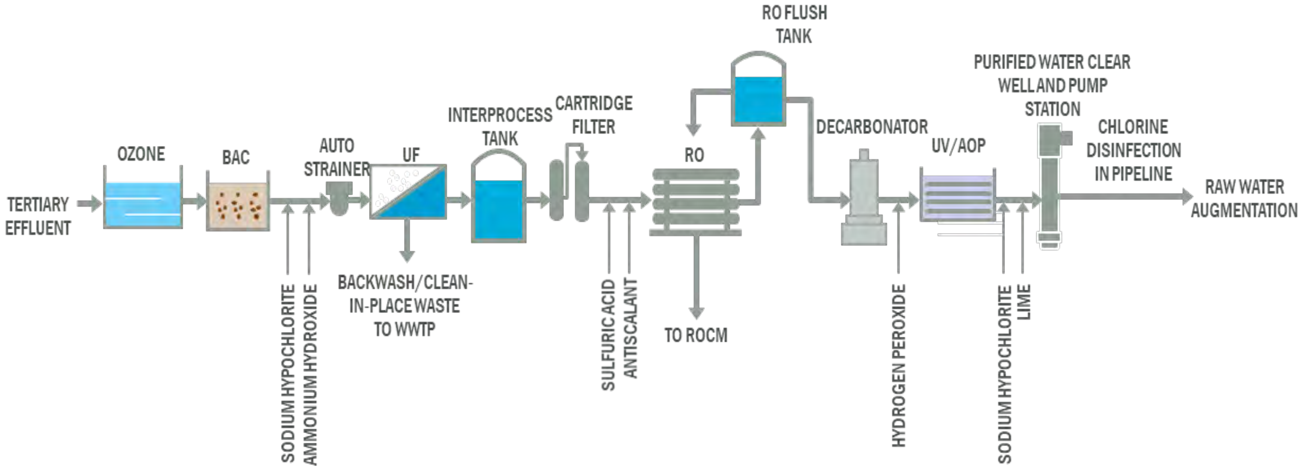

Figure 6-1. Proposed AWPF treatment train for the raw water augmentation portfolio

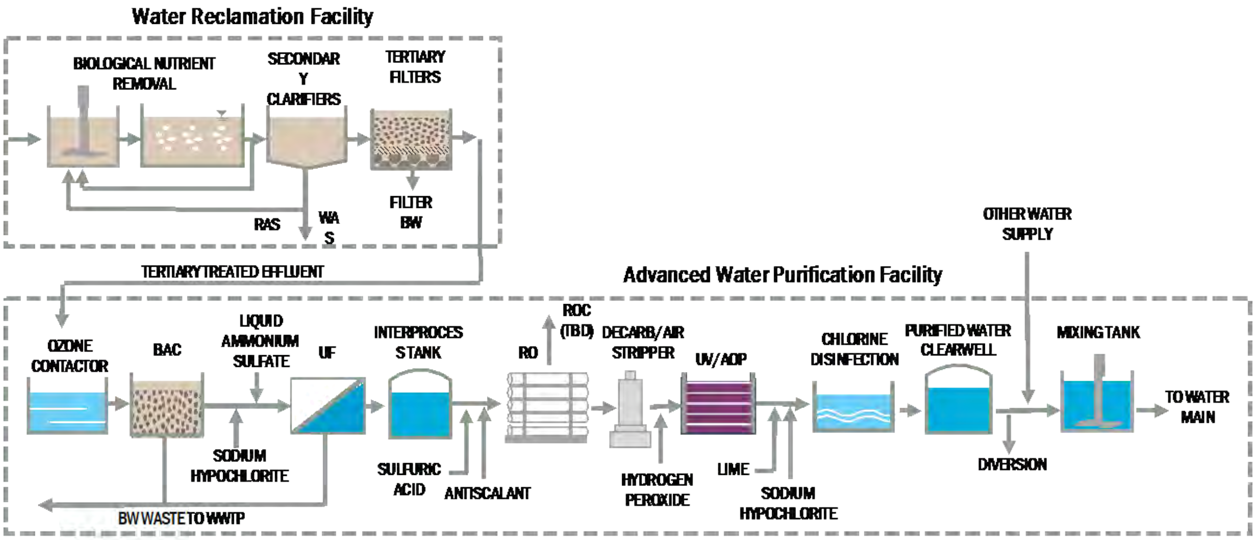

Figure 6-2. Proposed AWPF treatment train for the treated water augmentation portfolios

Table 6-1. Key Attributes of the Four RWA and TWA Recharge Portfolios

DPR Portfolio	Design Capacity (mgd)	AWPF Location	Source Supply	Delivery Point
Portfolio 1b RWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Penitencia WTP
Portfolio 1c TWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Up to 24 mgd to Milpitas Pipeline 4 mgd local delivery to City of San José and City of Santa Clara
Portfolio 1d TWA	24 mgd	Adjacent to SVAWPC	SJ/SC RWF	Up to 24 mgd to modulating valve vault at Penitencia WTP 4 mgd local delivery to City of San José and City of Santa Clara
West County TWA	24 mgd	Los Altos Treatment Plant	PA RWQCP and SV WPCP	West Pipeline

In the following sections, the four portfolios are evaluated based on their ability to comply with the regulatory requirements for public health (described in Section 2.1) and environmental compliance (described in Section 2.2). Because the TWA portfolios use the same treatment train, they are discussed collectively except to note any relevant portfolio-specific differences.

6.1.1 Pathogens

6.1.1.1 Portfolio 1b RWA

While RWA pathogen control criteria are still in development, the regulations are expected to be more stringent than IPR to account for the lost benefits of the environmental buffer. The addition of O_3/BAC pre-treatment increases pathogen control and redundancy, allowing the RWA train to exceed the anticipated pathogen reduction requirements (Table 6-2). The redundancy beyond the anticipated requirements for all pathogens will also allow for greater operational flexibility to deal with excursions.

Table 6-2. Pathogen Reduction Credits Expected for the Raw Water Augmentation Train

	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment[a]	0.4	0.2	0
O_3/BAC	6	6	1
MF	0	4	4
RO	2	2	2
UV-AOP	6	6	6
Free Cl_2	6	1	0
AWPF without surface water treatment plant	**20.4**	**19.2**	**13**
Surface Water Treatment Plant [b]	4	3	2
Total with surface water treatment plant	**24.4**	**22.2**	**15**
Anticipated Requirements	**15**	**13**	**13**

a. Tertiary effluent, having undergone secondary treatment, would be provided from the WWTPs. The credits in this row are associated with the secondary processes.

b. It is not clear whether the State Water Board will provide the default 4/3/2 credits for surface water treatment plants without studies demonstrating the effectiveness of the plant in the treatment of FAT effluents.

It should be noted that the State Board has not provided clear definition regarding how they will credit the surface water treatment plants in RWA settings. Their most recent written communication implies that the default 4/3/2 credits should not be assumed, and that site-specific testing may be required to demonstrate performance and assign specific LRV credits (SWRCB 2019). During the June 9, 2020 meeting with DDW, the State board confirmed that this additional effort may require studies evaluating pathogen reduction through the treatment processes, and the correlation of surrogate parameters to process performance. However, as noted in Section 3.2.1, the IAP encouraged Valley Water to "not accept the need to do full re-crediting of these facilities under certain circumstances," (Crook et al. 2020). Given the potential benefits of achieving an additional 4/3/2 credits through an RWA project approach, continued communication with the State Board regarding requirements for treatability studies and the impact of various raw water blending ratios on study requirements is recommended.

In the absence of water treatment plant credit, the train provides no redundancy for *Cryptosporidium* beyond the anticipated 13-log reduction requirement. In this case, additional efforts to enhance credit at the WWTP or AWPF, such as through a pathogen monitoring study or enhanced RO crediting, may be needed. This redundancy may be worth pursuing to provide greater flexibility for AWPF operations. In the absence of redundancy, excursions that cause any of the processes to drop below the stated *Cryptosporidium* reduction levels would require diversion of the resulting off-spec water.

6.1.1.2 TWA Portfolios

TWA is expected to require pathogen control that is at least as stringent as RWA. While an additional unit process (air stripping) has been added to the TWA train, it does not provide credit for pathogen reduction. Consequently, higher credits will need to be sought for the individual unit processes in the TWA trains to provide pathogen redundancy. As with the RWA train, *Cryptosporidium* is the pathogen driving the regulatory discussion because it provides the least amount of redundancy. For TWA, both a pathogen monitoring study and enhanced RO monitoring could be used to provide redundancy for *Cryptosporidium* control. The anticipated pathogen reduction for the TWA trains is provided in Table 6-3.

Table 6-3. Pathogen Reduction Credits Expected for the Treated Water Augmentation Train

	Virus	*Giardia*	*Cryptosporidium*
Tertiary Treatment[a]	0.5	0.5	0.5
O3/BAC	6	6	1
MF	0	4	4
RO[b]	2.5	2.5	2.5
UV-AOP	6	6	6
Air stripping	0	0	0
Free Cl_2	6	1	0
AWPF Total	21	20	14
Anticipated requirements	15	13	13

a. *Assumes pathogen monitoring study is performed at the wastewater treatment plant from raw through tertiary treatment to obtain higher pathogen credit. Higher credits beyond the conservative 0.5-log values shown may be possible.*

b. *Assumes enhanced monitoring used (e.g., strontium) to obtain higher credits for RO performance.*

After review of the proposed treatment train and log reduction credits shown in Table 6.3, the IAP noted that further investigation into treatment train redundancy requirements will be needed because TWA regulations are not currently available. However, the IAP also stated, "The treatment trains shown for the RWA/TWA portfolios using ozone/BAC pretreatment to FAT [...] offers the greatest chance for regulatory approval," (Crook et al. 2020). The IAP also stated that they do not recommend *alternative* treatment trains for further pilot testing; however, demonstration testing using the proposed treatment train of ozone/BAC followed by FAT and free chlorine can still offer valuable insight into operating and maintaining a DPR system that is protective of public health. Although the treatment train is well defined, questions about monitoring and control capabilities, consistency of maintaining pathogen LRVs and chemical control, and failure response strategies can be addressed through demonstration testing.

6.1.1.3 Pathogen Control Summary and Next Steps

Based on the scoring rubric described in Table in Section 3.7, both the RWA and TWA trains fall into the “light blue” category by meeting the anticipated 15/13/13 requirements (Table 6-4).

Table 6-4. Regulatory Considerations for Pathogen Control in the RWA And TWA Portfolios

Portfolio:	1B RWA	1C TWA	1D TWA
	≥15/13/13 ○	≥15/13/13 ○	≥15/13/13 ○
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Recommended next steps for pathogen control include:

- **Pathogen monitoring study**: Assuming additional credit will be required for the TWA portfolios, pathogen monitoring studies may be needed to obtain more extensive pathogen credits through the RWF. Currently the State Board is sponsoring research to develop methods for the sampling of pathogens in wastewater matrices. Findings from this effort—including SOPs—should be leveraged during the development of the test plan, and all efforts should be undertaken in conjunction with both DDW and the IAP.
- **Enhanced RO crediting**: In lieu of investing in additional pathogen control barriers, higher credits can be sought to increase redundancy. DDW has approved enhanced RO crediting (beyond the traditional credits assigned with electroconductivity and TOC monitoring) for the first time in San Diego’s Title 22 Engineering Report for the augmentation of the Miramar Reservoir. San Diego will use the monitoring of strontium—an inorganic species in the wastewater—to conservatively achieve 3-log reduction credit for RO. Based on testing at San Diego’s demonstration Pure Water Facility, it is anticipated that credits of 3.5-log or higher will be routinely demonstrated.
- **Surface water treatment plant crediting**: The fate of the surface water treatment plant remains uncertain for RWA projects based on DDW’s comments in the second edition of the DPR Regulatory Framework. Evidence of their continued interest in this topic includes the State Board’s sponsoring of WRF project 5049, “Benefits and Challenges in Pathogen Removal When Blending Advanced Treated Water with Raw Water Upstream of a Surface Water Treatment Plant in DPR.” Participation in this project or other similar efforts may be useful to help drive the regulatory conversation and argue for the inclusion of surface water treatment plant credits in RWA scenarios.

6.1.2 Chemicals

6.1.2.1 Portfolio 1b RWA

As described in Section 3, O_3/BAC has been shown to control of both chemical peaks and low-molecular-weight, unknown contaminants. In addition to these barriers at the AWPF, the RWA scheme relies on a number of other barriers to reduce the concentration of toxic chemicals, including enhanced source control, a high-quality feed water that has undergone both biological nutrient removal and tertiary filtration, and blending with other source water, and treatment at the surface water treatment plant.

6.1.2.2 TWA Portfolios

The TWA train incorporates air stripping as an additional layer of protection against chemicals. This barrier helps compensate for the reduction in blending and the loss of the downstream drinking water treatment plant in the TWA portfolios. Air stripping adds to the train's robustness by enhancing the volatilization of VOCs. The air stripping has been designed to provide >90 percent removal of THM, a volatile DBP commonly found in AWPF effluents, though it is also intended to control other volatile chemicals, both known and unknown. Decarbonators are included in the TWA treatment train to provide both air stripping for VOC removal and pH adjustment.

While temperature is a consideration for DPR, the need for temperature control should be considered on a case-by-case basis. The treated surface water from Penitencia and Rinconada WTPs is very close in temperature to the WW effluent from SJ/SC RWF. In these TWA portfolios, the temperature difference was about 1 to 2 degrees Fahrenheit, which did not indicate a need specifically for temperature reduction.

6.1.2.3 Chemical Control Summary and Next Steps

Based on the scoring rubric described in Table in Section 3.7, the RWA and TWA trains fall into the "light blue" and "medium blue" categories, respectively (Table 6-5). The RWA train is assigned a higher ranking due to the fact that it provides a wider set of barriers against toxic chemicals than the TWA options, including downstream treatment at the Penitencia WTP and blending. Because the requirements for chemical control in DPR remain undetermined, an approach with a broader set of barriers may be easier to permit.

Table 6-5. Regulatory Considerations for Chemical Control in the RWA And TWA Portfolios

Portfolio:	**1b RWA**	**1c TWA**	**1d TWA**
	High-quality WW to FAT train with enhanced robustness and multiple additional barriers ○	High-quality WW to FAT train with enhanced robustness and moderate additional barriers ◒	High-quality WW to FAT train with enhanced robustness and moderate additional barriers ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Recommended next steps for chemical control include:

- **Track the recommendations from the State Board's DPR-4 Research Project**: The State Board is currently supporting the DPR-4 research effort to understand the requirements to control chemical peaks and unknown contaminants. Findings from this effort are expected in the near future (by summer of 2020). Based on DDW's interaction with the DPR-4 team, they are likely to have further defined what requirements they will impose on DPR trains for chemical control.
- **Develop additional blending analysis:** The State Board is likely to be interested in understanding the extent of blending that the DPR projects will provide. Additional efforts to characterize how much blending occurs at different locations (spatial) in the distribution system and at different times of the day or the year (temporal) will likely be valuable for future DDW interactions. Per feedback from DDW at the June 9, 2020 meeting, they do not anticipate that there will be a blending requirement for TWA scenarios. Consequently, the fact that Portfolio 1c provides minimal to no blending at some points of the distribution system should not impact its feasibility.

6.1.3 Source Control

Given the uncertainty in the future requirements for the enhancements needed for DPR source control programs and the lack of additional direction from DDW during the June 9, 2020 meeting, all portfolios were assigned the “medium blue” scoring (Table 6-6), as described in Table . This scoring was assigned under the assumption that all the portfolios would be able to make the necessary enhancements to meet the stringent future source control requirements. Next steps for this topic include staying abreast of the findings from the State Water Board’s source control panel when they are released later this year. This report is likely to influence the State Board’s future source control requirements, and so it can be used to understand what the future modifications to source control might require.

In addition to understanding the outcomes of the State Water Board’s report, the IAP also recommended that Valley Water “[…] begin to discuss and document the details of the [source control] enhancements (for example, specific enhancements, responsible parties, communication between partners, response and enforcement of requirements) with the various [project] partners,” (Crook et al. 2020). Given that enhanced source control requires cooperation with the future project partner(s) supplying source water, initiating dialogue among the potential partners early can assist with smooth implementation of a future program.

Table 6-6. Regulatory Considerations for Source Control in the RWA and TWA Portfolios

Portfolio:	1b RWA	1c TWA	1d TWA
	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

6.1.4 Monitoring and Control

6.1.4.1 Portfolio 1b RWA

While an enhanced monitoring and control system will be a critical feature of all DPR systems, the requirements for any given portfolio must also take into account other barriers. In the RWA portfolio 1b, a number of additional barriers have been provided that reduce the system’s reliance on monitoring and control for public health protection. These barriers include:

- Pathogen control with a high degree of redundancy
- Robustness against chemicals with the addition of O_3/BAC pre-treatment
- Retention time in the pipeline and 3-MG purified water tank near Penitencia WTP
- Blending of purified water with other potable source waters
- Source control program meeting DPR requirements

The monitoring and control system for RWA will require significant enhancements over the GWR portfolios, but the stringency required is balanced by the system’s multiple, additional barriers. Consequently, the RWA portfolio receives the “medium blue” ranking for DPR monitoring and control.

Note that this ranking assumes that the purified water serves as a source water to the Penitencia WTP alone. Distributing the purified water to additional water treatment plants or the LGRP via the Central Pipeline may significantly increase the complexity of the control and coordination needed for the system.

6.1.4.2 TWA Portfolios 1c and 1d

Compared to the RWA portfolio, the TWA portfolios provide a lower degree of pathogen redundancy, meaning that the system will be *more* reliant on failure response to protect public health. This will likely increase the degree of monitoring and control of these systems compared to RWA. The barriers provided by the TWA trains that will impact their requirements for monitoring and control include:

- Pathogen control with a moderate degree of redundancy
- Robustness against chemicals with the addition of O_3/BAC pre-treatment and air stripping
- Retention time in the baffled clearwell of the AWPF providing 8 hours of response time
- Source control program meeting DPR requirements

One element that differentiates TWA portfolios 1c and 1d is the degree of available blending with other source waters. In certain parts of the distribution system, Portfolio 1c will provide minimal to no blending, particularly at the initial turnouts downstream of the tie-in to the Milpitas Pipeline. As the water travels down the pipeline and approaches the Penitencia WTP it will blend with the potable supplies from the WTP. The degree of blending available for local delivery to the cities of San José and Santa Clara remains unclear. Portfolio 1d, however, includes blending with other treated water supplies at the mixing vault near Penitencia WTP. As a result, Portfolio 1c may need a greater degree of monitoring and control than 1d. While the system may need to adapt to account for lower degrees of blending, DDW clarified at the June 9, 2020 meeting that blending is unlikely to be a requirement for TWA projects, maintaining the feasibility of projects like Portfolio 1c that may provide no blending. DDW also clarified that purified water in TWA applications that connect directly to the distribution system will be viewed as potable water supply, similar to incorporating other potable water supplies. However, some degree of treated water blending may still be considered beneficial in terms of corrosion control, aesthetics, and environmental justice.

Based on this discussion, Portfolio 1c and 1d fall into the “dark blue” and “medium blue” categories for monitoring and control requirements, respectively.

6.1.4.3 Monitoring and Control Summary and Next Steps

Based on the scoring in Table 6-7, the DPR portfolios receive either “medium blue” or “dark blue” rankings for monitoring and control.

Table 6-7. Regulatory Considerations for Monitoring and Control in the RWA and TWA Portfolios

Portfolio:	1b RWA	1c TWA	1d TWA
	Enhanced control system with *multiple* additional barriers (treatment, blending, retention) ◒	Enhanced control system with *moderate* number of additional barriers ●	Enhanced control system with *multiple* additional barriers (treatment, blending, retention) ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Recommended next steps for monitoring and control include:

- **Engage in WRF research project 4954**: Valley Water is currently an agency partner on WRF Project 4954 “Integration of High Frequency Performance Data for Microbial and Contaminant Control in Potable Reuse Treatment Systems” that seeks to develop and test a system for the rapid detection and response to failures. Findings from this study will likely provide useful information for future DPR demonstration testing at Valley Water and other agencies interested in DPR.

- **DPR demonstration testing:** The first agencies to pursue DPR projects will likely pursue testing to demonstrate their projects' ability to protect public health. Whether such testing will be a requirement in the future regulations is unclear, though such investments are often made to build support for the project with the regulators, public, IAP, and other stakeholders. Demonstration testing provides an excellent opportunity to develop and evaluate a DPR monitoring and control system.

6.1.5 Retention and Response Time

6.1.5.1 Portfolio 1b RWA

Portfolio 1b provides retention time prior to distribution in the conveyance infrastructure, in the 3-MG purified water tank, and through treatment in the Penitencia WTP. Based on a flowrate of 24 mgd, this infrastructure should provide more than 8 hours of retention time to initiate failure responses. Based on this evaluation, Portfolio 1b achieves the "medium blue" ranking for retention and response time.

6.1.5.2 TWA Portfolios

All of the TWA portfolios include an 8-hour baffled clearwell to provide time to respond to upstream treatment issues. This clearwell also provides hydraulic buffering to help manage demands in the distribution system and a location from which to divert off-spec water prior to distribution.

6.1.5.3 Retention and Response Time Summary and Next Steps

Based on the scoring in Table 6-8, the DPR portfolios receive "medium blue" rankings for retention and response time. Future efforts should seek to demonstrate that this level of retention time—in conjunction with the enhanced monitoring and control system—can detect and respond to any excursions or failures that occur at the AWPF. The findings from such an effort could be used to justify providing shorter retention times, assuming it could be demonstrated that it would not jeopardize public health.

Table 6-8. Regulatory Considerations for Retention and Response Time in the RWA and TWA Portfolios

Portfolio:	**1b RWA**	**1c TWA**	**1d TWA**
	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

6.1.6 TMF Capacity

Portfolios 1b, 1c, and 1d involve two large agencies—Valley Water and City of San José—that have an existing track-record of experience in advanced treatment and recycled water. Given this investment, it is presumed that these agencies will meet the State Board's initial bar for TMF capacity. Nevertheless, additional efforts will likely be required (even of the experienced agencies) to demonstrate that public health can be reliably protected under the more rigorous requirements of DPR. DDW has signaled that interagency coordination will be of greater importance for DPR to ensure that all elements of the system—from source control through distribution—are optimized for public health protection. Examples of heightened coordination include the need for enhancements to source control programs and potential future requirements for the optimization of wastewater treatment plants feeding DPR AWPFs. Agreements specifying these roles and responsibilities will likely be of greater importance than in IPR settings to ensure stable partnerships.

6.1.6.1 Portfolio 1b

Of the DPR scenarios, Portfolio 1b provides the most diverse set of barriers to protect against public health threats, including source control, blending, storage, and treatment at both the AWPF and Penitencia WTP. By spreading protections across these multiple treatment and management barriers, it is less reliant on a complex, sophisticated AWPF treatment and control system to protect public health. It is therefore likely to have lower TMF requirements than the TWA scenarios. As described in previous sections, however, multiple additional efforts may be required of any DPR project to further demonstrate this capacity. As with the IPR scenarios, the lack of existing interagency agreements may present a regulatory challenge for TMF.

6.1.6.2 Portfolios 1c and 1d

The TWA portfolios rely more heavily on the AWPF than the RWA and IPR scenarios. In line with the State Water Board's guidance, the TMF requirements of the agencies pursuing TWA will likely be highest due to the number and different types of treatment processes, monitoring, and control points. As with Portfolio 1b, the TWA portfolios will likely be required to undertake additional efforts to demonstrate this capacity. The lack of existing interagency agreements also poses a challenge for TMF in these portfolios.

6.1.6.3 TMF Summary and Next Steps

Based on the scoring in Table 6-9, the DPR portfolios receive "dark blue" rankings for TMF capacity. Multiple "next steps" listed in the DPR sections above will contribute to the agencies' TMF capacity, particularly those efforts that demonstrate the agencies' ability to coordinate and address the major DPR challenges. Positive outcomes from these efforts will help demonstrate TMF capacity and may allow the projects to achieve higher rankings for this category, i.e., to move up from "dark blue" to "medium blue" rankings.

Table 6-9. Regulatory Considerations for TMF in the RWA and TWA Portfolios

Portfolio:	1b RWA	1c TWA	1d TWA
	Agencies lacking formalized interagency agreements ●	Agencies lacking formalized interagency agreements ●	Agencies lacking formalized interagency agreements ●
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Recommended next steps for TMF capacity include:

- **DPR demonstration project and research testing**: As described previously, testing will be critical to demonstrate to the regulators, public, and other stakeholders that solutions can be implemented to address DPR challenges. Important topics to include in demonstration testing include those mentioned in this section, such as enhanced monitoring and control systems, verification of a system's ability to meet risk-based standards for pathogen control, and evidence that the treatment and management barriers can effectively address chemical peaks and unknowns. Based on the potable reuse experience in California, this type of demonstration testing is typically critical for the pioneering projects (e.g., Orange County Water District's groundwater injection project, San Diego's surface water augmentation project) in any new potable reuse paradigm. The need for demonstration testing will therefore be dependent on how quickly Valley Water and its partners intend to pursue DPR. Projects can reduce the need for such testing by waiting and relying on the experience of other agencies' projects. By leveraging others' experience, a project can reduce its investment in time and resources needed to design, test, and engage its stakeholders. Waiting for the development of regulations also provides better clarity for project planning. On the other hand, this approach requires a longer implementation timeline since it relies on the other agencies implementing projects and gaining experience for the industry at large. Pursuing a project prior to the development of regulations also allows its sponsors to help shape and control these requirements.

- **Further assessment of TMF capabilities among the portfolios:** As noted in Section 4.1.6, the IAP recommended that additional TMF capability criteria be developed to facilitate a comparison of TMF capability among the portfolios. Additional evaluation criteria such as availability of source water, funding ability, willingness of agency partners to collaborate, and status of interagency agreements were recommended by the IAP. The IAP also highlighted the importance of finalizing interagency agreements, as project feasibility will be based on a shared understanding among participating partner agencies.
- **Continue to engage partners on interagency agreements**: Based on feedback from DDW and the IAP, agreements that provide definition on the roles and responsibilities of the various agencies will be even more important for TMF assessments in DPR. The existence of such agreements demonstrates the project's ability to ensure the reliability of the potable reuse system from wastewater collection through distribution. Topics of interest for such agreements could include defining the requirements for enhanced source control programs, the quality of the secondary or tertiary effluent that is acceptable as a feed water to the AWPF, and who is responsible for upgrades and maintenance of the system.
- **Regulator and IAP engagement:** Maintaining interactions with the regulators and IAP are helpful for demonstrating TMF capacity regardless of the type of reuse, though it is particularly important for a new paradigm like DPR. Testing and research efforts should be done with the participation of DDW and the IAP to ensure that testing plans focus on the key issues of concern in their eyes and that the findings and conclusions benefit from their peer review and comments.

6.1.7 Additional Operational Modes for Greater TWA Flexibility

Valley Water is also evaluating ways to gain additional operational flexibility by blending the potable TWA sources into its Central Pipeline. In this way, TWA supplies could be distributed across the county for various end uses, including the LGRP and Rinconada WTP. Per discussions with DDW at the June 9, 2020 meeting, they stated that this configuration would likely not require that the downstream end uses obtain additional permits for potable reuse (e.g., GWR and RWA permits at LGRP and Rinconada WTP, respectively). Assuming the TWA water introduced into the drinking water distribution system meets the requirements for potable water, it would be viewed as any other potable source and suitable for downstream applications.

Nevertheless, this configuration may require modifications to other permits to account for an additional water source that will be discharged to the environment (e.g., at the LGRP) and be used as a new source to a drinking water treatment plant. For this Master Plan, it is assumed that once potable water is introduced into the Central Pipeline it becomes raw water and would be viewed as such at Rinconada, LGRP, and environmental discharges, and would be subject to existing requirements at those points of connection or discharge. Additional conversations with DDW and the Regional Board are recommended to further pursue this option and validate this assumption.

6.1.8 West County TWA Concept

An additional TWA option that is being developed qualitatively is the West County TWA concept. Given that the same treatment train is assumed for this concept, it will likely receive similar rankings as TWA Portfolios 1c and 1d. Based on feedback from DDW at the June 9, 2020 meeting, the presence of multiple source waters should not pose additional challenges for source control and monitoring and control beyond what was described in this section. The requirements for TMF capacity for this portfolio may also be elevated due to the larger number of entities that must be coordinated through interagency agreements.

6.2 Environmental Compliance Criteria

In general, DPR minimizes product water release into the environment because the AWPF effluent is introduced just upstream of a WTP or directly into the distribution system without passing through an environmental buffer. For most of the DPR portfolios and TWA concepts, the AWPF product water is contained within the WTP and distribution system, and therefore environmental requirements would not apply. However, the additional operational modes being considered by Valley Water—namely, the introduction of AWPF product water (potable water) into the Central Pipeline—would result in releases into the environment. The Central Pipeline has a number of turnouts into creeks in Santa Clara County and also provides water to the LGRP. Although the AWPF product water would be considered potable water at the time it enters the distribution system, it is unclear whether the Regional Board would require additional permits to allow the product water to be released into the environment or if the combined flow would be viewed as raw water and subject to existing discharge requirements. Additionally, the IAP's proposed alternative permitting strategy introduced in Section 2.2 may be applicable to DPR scenarios such as this. Given the lack of precedents for permitting DPR projects, it may be easier to implement this strategy for these portfolios compared to the IPR portfolios. It will be important to receive feedback from the Regional Board regarding requirements that may be associated with this operational strategy.

6.3 Summary of RWA and TWA Portfolios

A summary of the overall rankings for the DPR portfolios is presented in Table 6-10. Generally, the DPR portfolios contain more categories in the "medium blue" rankings, which is largely a reflection of the lack of regulatory certainty and existing precedents. Multiple new challenges need to be addressed and demonstrated to elevate the DPR rankings to the level of more established forms of reuse like GWR.

Table 6-10. Summary of public health regulatory considerations for the RWA and TWA portfolios

Portfolio:	1b RWA	1c TWA	1d TWA
Pathogens	≥15/13/13 ○	≥15/13/13 ○	≥15/13/13 ○
Chemicals	High-quality WW to FAT train with enhanced robustness and multiple additional barriers ○	High-quality WW to FAT train with enhanced robustness and moderate additional barriers ◒	High-quality WW to FAT train with enhanced robustness and moderate additional barriers ◒
Source Control	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒	Source control program likely to meet the enhanced requirements specified in future DPR regulations ◒
Monitoring and Control	Enhanced control system with *multiple* additional barriers (treatment, blending, retention) ◒	Enhanced control system with *moderate* number of additional barriers ●	Enhanced control system with *multiple* additional barriers (treatment, blending, retention) ◒
Retention and Response Time	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒	8 to 24 hours retention prior to distribution (e.g., reservoir, clearwell) ◒
TMF	Agencies lacking formalized interagency agreements ●	Agencies lacking formalized interagency agreements ●	Agencies lacking formalized interagency agreements ●
Legend:	○ *least complex*	◒ *medium complexity*	● *most complex*

Of the DPR portfolios, RWA has the highest ranking, which reflects a number of considerations, including:

- The State Board views RWA as having a lower risk profile than TWA.

- The portfolio incorporates a broad range of treatment and management barriers that spread the burden of public health protection across a wider range of elements.
- The RWA train provides the highest degree of treatment redundancy.

The TWA portfolios have more topics that fall into the “medium blue” category given the lower degree of redundancy and the subsequent increased reliance on treatment, monitoring, and controls.

As noted throughout the TM, there are multiple requirements that remain undetermined; assumptions have been made regarding topics such as minimum levels of pathogen redundancy, suitability of O_3/BAC for the control of unknown chemicals and chemical peaks, and the role of the surface water treatment plant in RWA. In the June 9, 2020 meeting and the IAP Report, DDW and the IAP provided additional insight into the feasibility of the portfolios, and this feedback was included in this evaluation. Of note, DDW and the IAP provided additional clarity on the role of the surface water treatment plant, the importance of interagency agreements, and confirmation of the technical challenges related to topics such as monitoring and control.

Interactions with the regulators and IAP should be used to solicit feedback on the feasibility of the DPR (and other IPR) portfolios. Based on feedback from DDW and the IAP, there were no components of the portfolios that were immediate “no-go” items that impacted feasibility. One key topic that the IAP addressed is surface water treatment plant crediting. The IAP noted the following:

- Some if not all of the current WTP LRV credits may be achieved, but further investigation is required
- Treatability studies will likely be required by DDW; however, full re-crediting of the WTPs may not be necessary under certain circumstances related to the level of blending of the AWPF product water with raw source waters

Additional feedback on these and other topics will be important to solicit from DDW. Understanding their concerns will be critical for modifying the portfolios and/or addressing these issues through future efforts.

These interactions should also seek to identify what work would be most productive in supporting the pursuit of the DPR portfolios. Demonstration testing will likely be a requirement for the initial projects pursuing DPR. Test plans should be developed in conjunction with both DDW and the IAP and could be used to address a multitude of issues, including:

- Demonstrating the effectiveness of a DPR-caliber monitoring and control system.
- Evaluating pathogen removal performance of the WWTP to gain additional LRV credits.
- Testing alternative forms of surrogate monitoring to enhance LRV credit through RO.

This information would help Valley Water to plan future efforts and advance preferred options for potable reuse. Continued interaction with the State Water Board, Regional Water Board, and IAP are encouraged.

Section 7: Summary and Next Steps

7.1 Summary

The Master Plan contains seven potable reuse portfolios—including GWR, SWA, RWA, and TWA—that have been evaluated in this TM. The regulations for the existing forms of reuse—GWR and SWA—were used to develop a set of six criteria for evaluating the IPR portfolios. Ranks were assigned to each of the criteria based on a number of factors, including both regulatory certainty, number of precedents, and the experience of other permitted projects. The same six criteria were used to evaluate the DPR portfolios as well, though assumptions needed to be made in the development of rankings due to the fact that the State Board has not yet developed DPR regulations. In general, the regulatory clarity and larger number of precedents provided a clearer regulatory compliance pathway for GWR portfolios—the reuse type with the longest history in California. The uncertainty and lack of precedents made it more difficult to achieve the same clear pathway for DPR. A summary of the rankings for the seven portfolios is shown in Table 7-1.

Table 7-1. Summary of Regulatory Considerations for Public Health in the Potable Reuse Portfolios

Reuse type:	GWR			SWA	RWA/TWA		
Portfolio:	**1a**	**2a/2b**	**4**	**Morgan Hill**	**1b RWA**	**1c TWA**	**1d TWA**
Pathogens	○	○	○	○	○	○	○
Chemicals	○	○	○	○	○	◒	◒
Source control	○	○	○	○	◒	◒	◒
Monitoring and control	○	○	○	○	◒	●	◒
Retention and response time	○	○	○	○	◒	◒	◒
TMF	◒	◒	◒	◒	●	●	●

Legend: ○ *least complex* ◒ *medium complexity* ● *most complex*

Generally, the scoring shows a range of regulatory compliance complexity that moves from more straightforward compliance with the GWR portfolios to increasing complexity moving to SWA, RWA, and then TWA. As discussed throughout the document, many of the "medium blue" and "dark blue" rankings are not fixed, but are initial starting points based on the lack of clarity on specific topics. Future efforts could be used to make the regulators more comfortable with these topics (and therefore lead to an upgrade in scoring). Such efforts include additional demonstration testing, for example, that might be used to establish the public health protectiveness of a candidate treatment train or to demonstrate the proper functioning of an enhanced monitoring and control system. This and other next steps are presented in the following section.

The IAP noted that of the potable reuse portfolios considered in this Master Plan, the GWR options (particularly Portfolio 1a) have the highest likelihood of meeting the desired project completion date of 2028 given the maturity of the GWR regulations. That being said, the IAP cautioned that even the GWR options take a significant amount of time to implement and require strong partnerships with participating agencies. The medium and dark blue shading associated with TMF considerations for all of the portfolios assessed highlights this critical recommendation from the IAP that "the agreements required with partner agencies should be pursued in earnest now," (Crook et al. 2020).

The portfolios must also demonstrate compliance with environmental discharge considerations. Generally, each portfolio must present a plan to address compliance with ROC and—in all but the DPR portfolios—purified water released to the environment. A summary of the regulatory considerations for environmental compliance rankings in the seven portfolios is shown in Table 7-2. Note that if the TWA scenarios included the release of AWPF product water into the Central Pipeline, compliance with environmental regulations may be required. As noted in Section 6, communication with the Regional Board regarding the regulatory requirements that maybe applicable to this scenario is recommended.

Table 7-2. Summary of Regulatory Considerations for Environmental Compliance in the Potable Reuse Portfolios

Reuse type:	**GWR**			**SWA**	**RWA/TWA**
Portfolio:	**1a**	**2a/2b**	**4**	**Morgan Hill**	**1b/1c/1d**
	Environmental Discharge of Purified Water				
SF Basin Plan	○	○	○	○	N/A
California Toxics Rule	○	○	○	◒	N/A
SNMP	○	○	○	N/A	N/A
Anti-degradation	○	○	○	○	N/A
Chlorine residual	○	○	○	○	N/A
Legend:	○ *least complex*		◒ *medium complexity*		● *most complex*

7.2 Next Steps

This regulatory compliance TM represents an initial evaluation of issues that may impact the feasibility of the potable reuse portfolios in the Master Plan. The rankings provided here could move based on a number of factors, including engagement and feedback from regulators on the portfolios, greater clarity on the future regulatory requirements for DPR, and additional efforts by Valley Water and its partners to address or resolve the issues marked in “medium blue” and “dark blue.” A number of immediate next steps have been identified in the potable reuse sections, including:

- Demonstration testing of the potable reuse treatment systems
- Evaluation of enhanced monitoring and control systems
- Continued engagement with partners on interagency agreements
- Pathogen monitoring campaigns to support higher WWTP LRV credits
- Studies to evaluate the amount of blending available in the SWA, RWA, and TWA portfolios
- Evaluation of surface water treatment plant performance and crediting in RWA scenarios and the impact of blending on requirements for treatability studies
- Communication with the Regional Board regarding the feasibility of ROC management strategies
- Communication with the Regional Board regarding AWPF product water release to confirm permitting requirements for all portfolios

Additional studies and next steps should be considered during future phases of project implementation. Once greater clarity is obtained on which portfolio(s) will be carried into future phases, additional studies will need to be completed to further support those pursuits. These include reuse-specific studies such as:

- Tracer studies to confirm aquifer retention time (GWR). IAP recommended studies be done at gradients produced by mounding and at expected pumping rate at drinking water wells.
- Examination of source water interactions with the aquifer (GWR). IAP recommended including assessments of the fate and transport of TOC, VOCs, and trace metals in near shallow wells near LGRP.
- Hydrodynamic studies to confirm mixing and dilution requirements in SWA reservoirs
- Tracer studies to validate hydrodynamic models (SWA)
- Preliminary studies related to ROC discharge and AWPF product water release for all portfolios to confirm the applicable environmental requirements and the feasibility of compliance with those requirements

Multiple years may be required to undertake the complete process of implementing a potable reuse project. Various steps are typically involved, starting with the development and testing of a potable reuse concept before moving into the design, permitting, construction, and start-up of the system. Two recently permitted projects—Monterey One Water's GWR project and San Diego's SWA project—were both pursued with expedited timelines and required more than 10 years for completion. Example timelines are presented for Monterey (Figure 7-1) and San Diego (Figure 7-2).

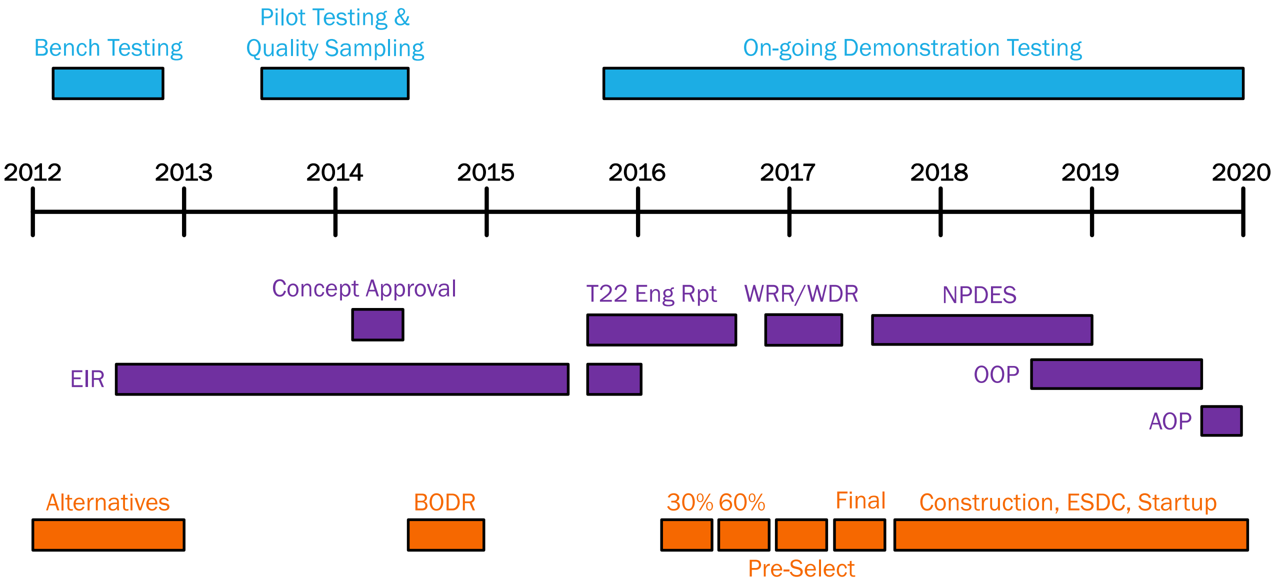

Figure 7-1. Project timeline for Monterey One Water's Pure Water Monterey groundwater recharge project

The colors denote research and testing efforts (blue), permitting efforts (purple), and design and construction (orange)

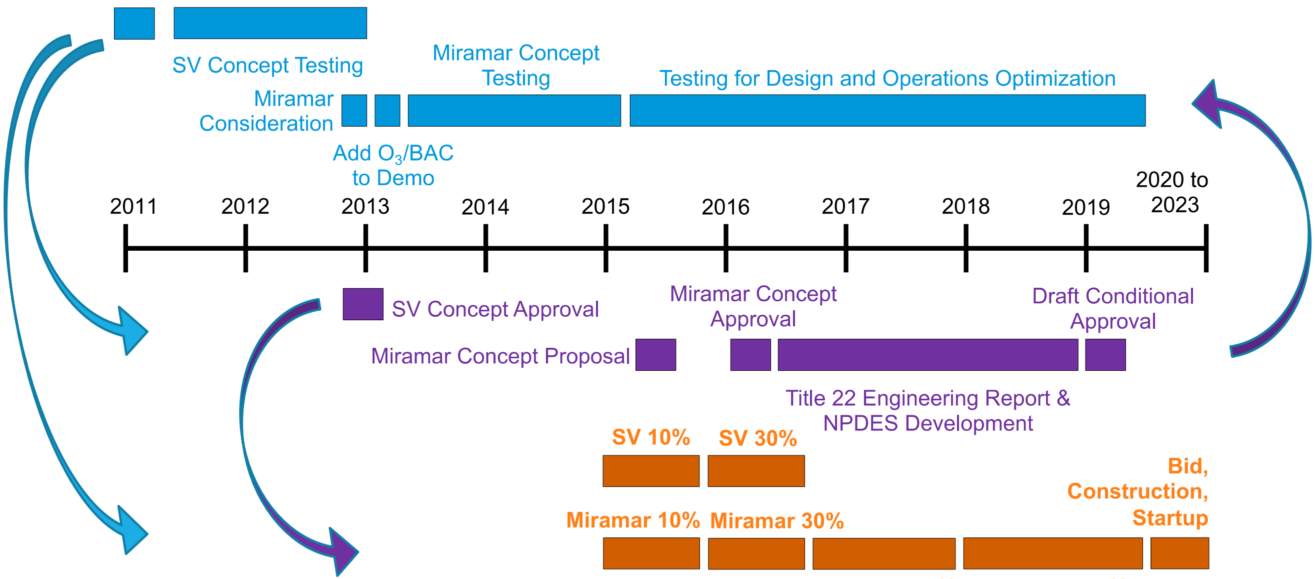

Figure 7-2. Project timeline for the City of San Diego's North City Pure Water project for surface water augmentation

Colors denote research and testing efforts (blue), permitting efforts (purple), and design and construction (orange)

Section 8: NPR System Expansion

Each of Valley Water's Partner Agencies already produce disinfected tertiary recycled water and do not have plans to produce other types of non-potable recycled water at this time. Therefore, only the requirements for disinfected tertiary recycled water are included in the summary provided in Table 8-1. The requirements are organized into categories for the protection of public health and the environment, as all non-potable end-uses for the recycled water impact both of these categories.

Table 8-1. Summary of Regulatory Requirements for Disinfected Tertiary Recycled Water

Requirements for Disinfected Tertiary Recycled Water (Non-potable Reuse)	
Public Health Criteria	
Treatment Criteria	Oxidation and tertiary filtration complying with the following criteria: • Coagulant addition upstream of filtration, as needed • Filter loading rate ≤ 5 gpm/sf • Filter effluent turbidity ≤ 2 NTU on a 24-hour average, ≤ 5 NTU more than 5% of the time, and ≤ 10 NTU at any time Disinfection via: • Chlorine providing 450 mg-min/L CT and at least a 90-minute modal contact time, OR a process that has been demonstrated to achieve 5-log virus reduction using the indicators F-specific bacteriophage MS2 or polio virus • Total coliform bacteria from final effluent samples must not exceed a 7-day median concentration of 2.2 MPN/100 mL, 23 MPN/100 mL more than once in any 30-day period, and 240 MPDN/100 mL at any time
Source Control	Must meet general industrial pretreatment and pollutant source control program requirements
Monitoring and Control	The following monitoring and control strategies are required: • Flow rate measurement of filter effluent • Turbidity measurement of filter influent and effluent • Chlorine and flow rate measurement to monitor chlorine disinfection • Daily (5 days per week) lab analysis of coliform samples • Collection of online records from monitoring equipment for compliance • DDW approval of a Title 22 Engineering Report detailing design criteria and monitoring and reporting strategies.
Environmental Criteria	
Order 2016-0068-DDW, Water Reclamation Requirements	The recycled water produced for non-potable uses shall: • Not degrade groundwater and/or surface water • Not create nuisance conditions
California Water Code Sections 1210-1212, Wastewater Effluent Water Rights	A wastewater change petition must be filed with the Division of Water Rights if the recycled water project will decrease the amount of water in a waterway. This petition is submitted by the owner of the impacted wastewater treatment plant.
SF Bay Basin Plan	The recycled water must comply with the requirements included in the SF Bay Basin Plan. Compliance with the applicable water quality objectives (depending on the location of the project in Santa Clara County) must be demonstrated through the application process for producing non-potable recycled water.
Santa Clara Subbasin SNMP	Numeric groundwater quality objectives that align with the SF Bay Basin Plan for TDS, nitrate (as NO_3), and nitrate plus nitrite (as N)

The Master Plan does include options to expand the regional reliability of the recycled water systems through the linking of systems via interties. Assuming that the individual recycled water producers continue to meet the regulatory requirements for both their tertiary disinfected and environmental discharges, there should not be additional regulatory requirements for the systems. One issue that may need to be addressed relates to defining roles and responsibilities in an intertied system. To ensure compliance with all applicable regulations, coordination among the participating agencies will be critical, as the water being distributed to customers throughout Santa Clara County may come from a number of sources. This topic should be raised at a future meeting with both the State and Regional Boards.

Section 9: ROC Management

The primary approach for ROC management identified by GHD for all portfolios involves the discharge of ROC into South San Francisco Bay. The exception to this is the SWA portfolio, where the AWPF is located at Morgan Hill and discharge to the Bay is not feasible. GHD analyzed each portfolio to develop ROC management strategies that comply with the SFB Basin Plan and the CTR. GHD's assessment of ROC discharge compliance with the applicable environmental requirements identified some contaminants that may pose environmental compliance issues, depending on the ROC management strategy and the location of ROC discharge. For GHD's complete analysis, refer to Task 6 – Evaluation of ROC Management Options Final Report (GHD 2020).

As part of the master planning process, the IAP reviewed GHD's ROC management strategies and provided feedback regarding the feasibility of the approaches considering compliance with discharge requirements and the overall project schedule. In addition to summarizing GHD's results and ROC management strategies, the following section includes the IAP's recommendations and further assessment regarding the relative complexity of ROC discharge compliance.

9.1 Overview of Applicable Environmental Discharge Requirements

Compliance with the SFB Basin Plan has established beneficial uses for the water within the SF Bay Basin and defines associated narrative and numeric water quality objectives to preserve the beneficial uses. The CTR defines additional numeric water quality objectives for toxic pollutants. All discharges that enter the waters protected by the SFB Basin Plan (surface and groundwater) must comply with all applicable narrative and numeric water quality objectives. For each GWR portfolio, a ROC waste stream will be generated during RO treatment that will be discharged into receiving waters included in the SFB Basin Plan.

In order to assess compliance with the applicable water quality objectives, GHD estimated the water quality of the *undiluted* ROC for each portfolio and compared it with the USEPA's Priority Pollutants List. Through their analysis, a number of constituents were identified to have the potential to cause future compliance issues. The constituents identified were dependent on the source water quality and location of ROC discharge—San José, Palo Alto, or Sunnyvale. Table 9-1 provides a summary of GHD's preliminary estimate of constituents that need to be addressed through ROC management, based on the 95th percentile concentrations in the ROC.

Table 9-1. Summary of GHD's estimate of constituents that require ROC management for regulatory compliance

San José Portfolio 1a	Palo Alto Portfolio 2a and 4	Sunnyvale Portfolio 2b and 4
Copper	Copper	Copper
Cyanide	Cyanide	Cyanide
Nickel	Nickel	Nickel
Selenium	Selenium	Selenium
Zinc	Zinc	Dibromochloromethane
Dibromochloromethane		Dichlorobromomethane
Dichlorobromomethane		Zinc

To address the potential concerns, GHD developed various ROC management strategies and evaluated their ability to comply with the SFB Basin Plan and CTR. As a first step, *dilution* with available wastewater effluent was considered. GHD assessed each portfolio to determine what percentage of the target AWPF production flow could be met when considering the benefits of dilution alone. In this case, a 100 percent value means that dilution alone would allow the project to meet 100 percent of its target AWPF capacity. Table 9-2 summarizes GHD's results for multiple production scenarios considering various assumptions for constituent concentrations used to determine compliance with the average monthly effluent limit (AMEL) and the maximum daily effluent limit (MDEL). Note that compliance with existing requirements for selenium and zinc were not considered while developing these production target percentages (see Table 9-2 footnote). GHD's report (GHD 2020) provides additional details regarding the assumptions, target flows, and production flows used to determine the percent of production results presented in Table 9-2.

Table 9-2: Summary of GHD's Results Showing Percent of Production Target Achieved for Each Portfolio with Dilution Alone[a]

	% of Production Target Met Assuming 95th Percentile MDEL and Average AMEL (Contaminant of Concern)			% of Production Target Met Assuming 95th Percentile MDEL and 95th Percentile AMEL	% of Production Target Met Assuming 95th Percentile MDEL and 95th Percentile AMEL
Portfolio	2025	2035 Lower Bound	2035 Upper Bound	2035 Lower Bound	Lowest Daily Flows by Month
Portfolio 1 San José	100% (None)	100% (None)	100% (None)	100% (None)	N/A
Portfolio 2a Palo Alto	82% (Copper)	73% (Copper)	81% (Copper)	46% (Copper)	51% (Copper)
Portfolio 2b Sunnyvale	51% (Copper)	45% (Copper)	51% (Copper)	3% (Copper)	N/A
Portfolio 4 Sunnyvale	92% (Copper)	88% (Copper)	92% (Copper)	52% (Cyanide)	N/A
Portfolio 4 Palo Alto	68% (Copper)	62% (Copper)	64% (Copper)	27% (Copper)	30% (Copper)

a. *GHD's results showed potential compliance issues with selenium for Portfolios 2a, 2b, and 4. Due to ongoing assessments by the EPA (Aquatic Life and Aquatic-Dependent Wildlife Criteria for Selenium in California's San Francisco Bay and Delta, 2016) and USGS (Status of Selenium in South San Francisco Bay – A Basis for Modeling Potential Guidelines to Meet National Tissue Criteria for Fish and a Proposed Wildlife Criterion for Birds, 2018), a compliance determination was not made by GHD and additional management approaches were not considered for minimizing the threat of selenium in the ROC discharge. Additionally, GHD's analysis notes that zinc had previously been eliminated as a concern due to its low attenuation factor, but that upon further analysis, GHD recommended further evaluating zinc.*

As shown in Table 9-2, blending with available wastewater was estimated to be insufficient for portfolios that include ROC discharge at Palo Alto (Portfolios 2a and 4) and Sunnyvale (Portfolios 2b and 4). In addition to considering constituents regulated by the CTR, other compliance considerations were qualitatively assessed by GHD, such as (1) the potential for exceedance of the selenium water quality objective in Portfolios 2a, 2b, and 4, (2) current and future nutrient concerns, (3) acute and chronic toxicity, and (4) contaminants of emerging concern. To address these potential issues and the lack of dilution required for Palo Alto and Sunnyvale portfolios, GHD developed a number of ROC management options, including:

- Blending and discharge using an existing outfall
- Blending and discharge under a separate permit and/or an innovative permitting strategy
- Enhanced mixing outfall
- Discharge to a deep water outfall

- Evaporation ponds

Other strategies, including ROC treatment and deep well injection, were eliminated from further consideration through the evaluation process. ROC treatment was found to be ineffective at reducing some of the constituents that may cause compliance issues such as chelated metals and selenium, and the IAP noted that the proposed treatment strategies are unlikely to be implemented within the project schedule timeline (Crook et al. 2020). Deep well injection was eliminated due to Valley Water's commitment to preserving their local groundwater resources. It is also important to note that, when considering the feasibility of the proposed ROC management strategies, further investigation regarding compliance with selenium, zinc, acute and chronic toxicity, the potential for future stricter nutrient limitations, and contaminants of emerging concern should be considered during future phases of project selection and implementation because these parameters were not quantitatively addressed in GHD's analysis.

The ROC management strategies for the DPR portfolios were not evaluated separately because they would be the same approaches as described for the GWR portfolios. One potential benefit of the DPR scenarios compared to the GWR options is that RWA and TWA treatment trains include ozone and BAC pretreatment prior to MF and RO. As described in Section 3.3.1, O3/BAC can reduce the concentration of CECs and organics in both the purified water stream *and* the ROC. This improved ROC quality may be beneficial in the future permitting of the DPR trains compared to GWR.

9.2 Summary of ROC Management Strategies

Considering the various ROC management strategies, GHD selected feasible approaches for each project portfolio. The following subsection further describes the ROC management strategies, noting which portfolios they apply to, the general challenges associated with each strategy, as well as portfolio-specific constraints.

Blending with discharges at existing outfalls. The ROC management option recommended by the IAP is to blend the ROC with treated wastewater effluent and discharge through an existing outfall. Their rationale for recommending this approach was that this may be the only one achievable by the 2028 timeline (Crook et al. 2020). One issue with this approach, however, is that it would constrain the capacity at both Palo Alto (Portfolios 2a and 4) and Sunnyvale (Portfolios 2b and 4) to levels lower than the target annual permeate production (Table 9-2). To address this, the IAP recommended that alternative compliance standards be discussed with the Regional Board including the use of mass-based effluent limits in lieu of concentration-based limits. The IAP also recommended that Valley Water pursue inter-agency agreements to define each entity's roles and responsibilities related to NPDES permitting of the ROC discharge, as one permit would likely govern the commingled discharge of the ROC and treated wastewater effluent. Recommended next steps to address the potential challenges associated with this approach are to (1) further discuss this strategy and alternative compliance approaches with the Regional Board and other agencies with jurisdiction, and (2) work to obtain the necessary inter-agency agreements required for permitting the ROC discharge.

Blending at a new outfall near an existing outfall. Another approach applicable to the San José GWR Portfolio (Portfolio 1a) involves the discharge of ROC through a new outfall that extends just beyond the current outfall weir at the SJ-SC RWF. The benefit of this approach is that it meets the target production goals for the project and complies with discharge limits according to GHD's analysis. Unlike most precedents, the blending of the two flows would occur in the environment and not prior to discharge. This novel approach should be discussed with the Regional Board to ensure that dilution credit from the SJ-SC RWF effluent would still be allowed. There is also the potential for complex regulatory oversight associated with building the new outfall, which could result in schedule delays throughout the implementation process making it difficult to meet the proposed project deadline of 2028 (Crook et al. 2020). Finally, although the discharge from SJ-SC RWF and the ROC would be separated, there would still likely be coordination required between Valley Water and the City of San José for the NPDES Permit due to the proposed proximity of the discharges and the potential to receive dilution of the ROC by the treated wastewater effluent. Recommended next steps include (1) discuss the proposed approach with the Regional Board and other agencies with jurisdiction, (2) evaluate schedule and permitting requirements for implementing a new outfall, and (3) work to obtain the necessary inter-agency agreements required for permitting the ROC discharge.

Blending at a new outfall with enhanced mixing. Another ROC management strategy that would be applicable to all GWR portfolios is the development of a new outfall that could provide enhanced mixing of the ROC in the SF Bay. This strategy may have challenges due to the environmental dilution required to be in compliance with discharge requirements for all constituents (Table 9-1) as well as the potential for complex regulatory oversight associated with building a new discharge outfall through endangered species habitat. Additionally, GHD noted that a new outfall to provide enhanced mixing was proposed by Palo Alto in the 1980s but was denied due to environmental impact concerns, and so the approval of this approach may be uncertain for Portfolios 2a and 4. These challenges may result in significant schedule delays similar to those noted for building a new outfall in San José. The benefits of this approach include the potential to receive more dilution credit than what is achieved at the existing outfalls, and the potential to avoid inter-agency agreements for the NPDES permit because Valley Water may be able to obtain their own, separate permit. Recommended next steps associated with this strategy include (1) further assess potential dilution credit that could be achieved depending on outfall design, (2) discuss approach with Regional Board and other agencies with jurisdiction (e.g., California Department of Fish and Wildlife, San Francisco Bay Conservation and Development Commission, etc.) to understand the feasibility of developing a new outfall, and (3) evaluate schedule requirements for implementing a new outfall.

Blending at a deep water outfall. The use of a deep water discharge outfall is only applicable to Portfolios 2a and 4 because an existing outfall is located near Palo Alto, and may have enough capacity to accept the ROC produced in these portfolios. This outfall may also allow for increased dilution credit compared to using an existing outfall, and would allow the AWPF to meet production capacity per GHD's analysis. However, challenges associated with this approach include the need for potentially complex inter-agency agreements with both the City of Palo Alto and Silicon Valley Clean Water as well as important unknowns such as whether the capacity of the outfall can accommodate the ROC and what level of dilution would be achieved. Recommended next steps for this strategy include (1) verify the capacity and dilution of the existing deep water outfall, (2) evaluate schedule requirements for connecting to this existing outfall, and (3) work to obtain inter-agency agreements to define roles and responsibilities for permit compliance.

Evaporation ponds. This approach is only applicable to the SWA portfolio at Morgan Hill. This strategy proposes the use of lined evaporation ponds covering an area of approximately 115 acres. Valley Water does not currently own land available for this purpose, and so the location of the evaporation ponds would be determined during future planning for this portfolio. Regulatory compliance challenges with this portfolio would depend on the land selected for this purpose, and what, if any, beneficial uses the land has been identified to have. Until this ROC strategy is more clearly defined, the potential regulatory compliance challenges associated with the approach are unclear. Recommended next steps associated with this strategy include (1) identify a suitable location for the evaporation ponds, (2) discuss regulatory approach with Regional Board and other agencies with jurisdiction, and (3) evaluate schedule requirements for implementing a new outfall.

Table 9-3 summarizes the strategies GHD evaluated, highlighting the challenges and benefits associated with the approach and recommended next steps for Valley Water to consider during future phases of project selection and implementation.

Table 9-3. Overview of ROC Management Strategies Evaluation (GHD 2020)

ROCM Approach	Portfolio Applicability	Approach Benefits	Approach Challenges	Recommended Next Steps
1. Existing Outfall & IAP Recommendation Use existing outfall and rely on blending with current discharge	Portfolio 1a – San José	• Based on GHD's analysis, discharge would be compliant with applicable discharge requirements • Based on GHD's analysis, meets target AWPF production capacity • May provide the fastest permit approval process due to avoidance of developing a new outfall	• A new permit would be necessary that would require coordination between Valley Water and City of San José • Inter-agency agreements would be required to commingle discharge flows	• Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Obtain inter-agency agreements to define roles and responsibilities for permit compliance

	Portfolio 2a – Palo Alto
	Portfolio 2b – Sunnyvale
	Portfolio 4 – Palo Alto and Sunnyvale
		• Based on GHD's analysis, discharge would be compliant with applicable discharge requirements if the AWPF production rate is lowered to ensure sufficient blending
		• May provide the fastest permit approval process due to avoidance of developing a new outfall
			• There is uncertainty regarding the willingness of the Regional Board to consider alternative compliance assessments such as mass-loading based objectives
			• Recycled water capacity is limited due to minimum discharge needed for dilution:
			  • 2a: 46% - 82% of target capacity (depending on assumptions)
			  • 2b: 3% - 51% of target capacity
			  • 4PA: 27% - 68% of target capacity
			  • 4SV: 52% - 88%
			• A new permit would be necessary that would require coordination between Valley Water and City of Palo Alto/Sunnyvale
				• Discuss regulatory approach with Regional Board and other agencies with jurisdiction and determine whether alternative limits such as mass-based requirements could be applied
				• Obtain inter-agency agreements to define roles and responsibilities for permit compliance

2. New Outfall Blending at a new outfall near an existing outfall	Portfolio 1a – San José	• Based on approach assumptions, discharge would be compliant with applicable discharge requirements • Based on GHD's analysis, meets target AWPF production capacity	• Dilution with San José discharge in the environment (rather than prior to discharge) may limit ability to receive dilution credit • New outfall may not be feasible by 2028 due to environmental regulatory requirements (endangered species present) • A new permit would be necessary that would require coordination between Valley Water and City of San José	• Further discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for implementing a new outfall • Obtain inter-agency agreements to define roles and responsibilities for permit compliance
3. New Outfall with Enhanced Mixing Discharge at a new enhanced mixing outfall	Portfolio 1a – San José Portfolio 2a – Palo Alto Portfolio 2b – Sunnyvale Portfolio 4 – Palo Alto and Sunnyvale	• May offer ability to receive more dilution credit compared to existing outfall or building a new shallow outfall • Based on GHD's analysis, meets target AWPF production capacity • May not require coordination with the Project Partner to obtain an NPDES Permit	• New outfall may not be feasible by 2028 due to environmental regulatory requirements (endangered species present) • The amount of dilution achieved by the new outfall still needs to be confirmed and is not guaranteed • Development of an outfall extension at Palo Alto was not permitted in the 1980s, and so approval for this approach is not certain	• Further assess potential dilution credit that could be achieved depending on outfall design • Discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for implementing a new outfall
4. Deep Water Discharge Outfall Discharge at an existing deep water outfall at SVCW	Portfolio 2a – Palo Alto Portfolio 4 – Palo Alto	• May offer ability to receive more dilution credit compared to Option 1 • Based on GHD's analysis, meets target AWPF production capacity	• The capacity of the outfall is unknown and must be verified • A new permit would be necessary that would require coordination between Valley Water and Silicon Valley Clean Water and the City of Palo Alto	• Verify capacity and dilution of the existing deep water outfall • Evaluate schedule requirements for connecting to the existing outfall • Obtain inter-agency agreements to define roles and responsibilities for permit compliance
5. Evaporation Pond Discharge into a lined evaporation pond in Morgan Hill	SWA Portfolio	• Provides a potential option for disposal of ROC produced far from the SF Bay • There may be other site-specific benefits that may arise after a feasible location is identified	• Requires a significant amount of land that would need to be obtained by Valley Water • There may be other site-specific challenges that may arise after a feasible location is identified	• Identify a suitable location for the evaporation ponds • Discuss regulatory approach with Regional Board and other agencies with jurisdiction • Evaluate schedule requirements for connecting to the existing outfall

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Appendix B-2: Regulatory Framework Technical Memorandum

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75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

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Appendix B2

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From:	Jenny Gain, Brown and Caldwell Team Project Manager
Copy to:	David Tucker, Valley Water Assistant Project Manager

Prepared by:	Erin Mackey, Brown and Caldwell Brian Pecson, Trussell Technologies

Reviewed by:	Wendy Broley, Brown and Caldwell Shane Trussell, Trussell Technologies

Table of Contents

List of Figures iv

List of Tables v

Section 1: Overview of Water Reuse Policy in California 1

1.1 History and Relevant Regulations 1

1.2 Regulatory Agencies' Responsibilities 1

    1.2.1 State Water Resources Control Board 1

    1.2.2 Regional Water Quality Control Boards 2

1.3 Recycled Water in Santa Clara County 2

1.4 Recycled Water Regulatory Structure 3

Section 2: Non-potable Reuse 4

2.1 Approaches 4

2.2 Regulatory Summary 5

2.3 Regulatory Requirements 7

    2.3.1 Public Heath Criteria 7

    2.3.2 Environmental Criteria 7

    2.3.3 Permitting Approaches 8

Section 3: Potable Reuse 11

3.1 Approaches 11

3.2 Groundwater Recharge Regulatory Requirements 12

    3.2.1 Regulatory Summary 12

    3.2.2 Public Health Criteria 12

    3.2.3 Environmental Criteria 16

    3.2.4 Permitting Approaches 18

3.3 Surface Water Augmentation Regulatory Requirements 23

    3.3.1 Regulatory Summary 23

    3.3.2 Public Health Criteria 23

    3.3.3 Environmental Criteria 27

    3.3.4 Permitting Baseline Approach 30

3.4 Direct Potable Reuse 32

    3.4.1 Regulatory Summary 32

    3.4.2 Key Considerations 33

Section 4: Residuals Management 36

4.1 NPDES Permits 37

    4.1.1 Existing NPDES Permits 37

    4.1.2 Basin Plans 42

4.1.3 Waste Discharge Requirements for Nutrients to San Francisco Bay 43
4.2 RO Concentrate Management 43
4.2.1 Sanitary Sewer Discharge 43
4.2.2 Discharge Through an Outfall 44
4.2.3 Engineered Wetlands and Treatment Cells 44
4.2.4 Evaporation Ponds 45
4.2.5 Deep-Well Injection 45
4.3 Backwash Streams 45
4.4 NEPA/CEQA Implications 45
4.4.1 NEPA Requirements 46
4.4.2 CEQA Requirements 46
4.4.3 CEQA-Plus Requirements 48
Section 5: Future Policy Recommendations 48
5.1 Opportunities for Unified Local Policies 48
5.2 Other Potential New Policies 48
Section 6: References 49

List of Figures

Figure 2-1. California recycled water regulations have been streamlined to support the development of NPR projects 5
Figure 3-1. Forms of potable reuse in California 11
Figure 3-2. Montebello Forebay groundwater recharge spreading basins in Los Angeles County 13
Figure 3-3. Reverse osmosis treatment skid at the Silicon Valley Advanced Water Purification Center 14
Figure 3-4. Summary of baseline and high-capacity permitting approaches for groundwater recharge via spreading and injection 18
Figure 3-5. Public health protections provided by groundwater recharge projects with (a) baseline permitting approaches, and (b) alternative permitting approaches 20
Figure 3-6. Padre Dam 0.1-mgd demonstration facility 21
Figure 3-7. Ozone treatment system at the Donald C. Tillman Advanced Water Purification Pilot project 22
Figure 3-8. Example of a hydrodynamic model replicating a tracer study 24
Figure 3-9. Demonstration pure water facility at San Diego's North City Water Reclamation Plant 31
Figure 3-10. Six DPR research topics identified by the State expert panel 32
Figure 3-11. Framework for regulating DPR in California, released by the State Board's DDW in April 2018 33
Figure 3-12. Diversity of removal mechanisms provides a high degree of control for chemicals and mitigates unknown chemical contaminants 35
Figure 4-1. CEQA process flow chart 47

List of Tables

Table 1-1. Summary of Regulatory Criteria and Requirements for Water Reuse Applications in Santa Clara County........ 3

Table 2-1. Typical End Uses for Recycled Water 5

Table 2-2. Water Quality Criteria for NPR........ 7

Table 2-3. Monitoring Requirements for NPR (per 2016 General Order)........ 10

Table 2-4. Sampling Requirements for NPR (per Title 22) 10

Table 3-1. Summary of Additional Criteria for Groundwater Replenishment Reuse Applications 16

Table 3-2. Salt and Nutrient Management Plan Water Quality Objectives for the Santa Clara and Llagas Subbasins (Regional Board, CC Region 2017; Regional Board, SFB Region 2017)........ 17

Table 3-3. Typical Permit Requirements for Groundwater Recharge Projects 19

Table 3-4. Summary of Treatment, Dilution, and Theoretical Retention Time Criteria for SWA........ 25

Table 3-5. Chapter 3. Article 5.3. Indirect Potable Reuse: Surface Water Augmentation 26

Table 3-6. Water Quality Control Plan for the SFB Basin Bacterial Criteria for Relevant Beneficial Uses........ 27

Table 4-1. Effluent Limits for San José/Santa Clara RWF 38

Table 4-2. Effluent Limitations for Sunnyvale WPCP........ 39

Table 4-3. Effluent Limitations for Palo Alto RWQCP 40

Table 4-4. Effluent Limitations for SCRWA’s Discharge Point 001 41

Table 4-5. Effluent Limitations for SCRWA’s Discharge Point 002 41

Table 4-6. Beneficial Uses of Relevant Water Bodies in Santa Clara County........ 42

List of Abbreviations

°C	Celsius
°F	Fahrenheit
µg/L	micrograms per liter
AB	Assembly Bill
AFY	acre-foot/feet per year
AGR	agricultural supply
AOP	advanced oxidation process
AWTF	advanced water treatment facility
BA	Biological Assessment
BAC	biological activated carbon
Basin Plan	Water Quality Control Plan for the San Francisco Bay Basin
BOD_5	biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
CC	Central Coast
CCC	criterion continuous concentration
CCR	California Code of Regulations
CDPH	California Department of Public Health
CECs	contaminants of emerging concern
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CMC	criterion maximum concentration
COLD	cold freshwater habitat
COMM	commercial and sport fishing
CTR	California Toxics Rule
CWC	California Water Code
CWEA	California Water Environment Association
DBPs	disinfection by-products
DDW	Division of Drinking Water
District	Santa Clara Valley Water District
DPR	direct potable reuse
DS2.2	Disinfected secondary-2.2 recycled water
DS23	Disinfected secondary-23 recycled water
DT	Disinfected tertiary recycled water
DWTF	drinking water treatment facility
EA	Environmental Assessment
EIR	environmental impact report
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EST	estuarine habitat
FAT	full advanced treatment
FRSH	freshwater replenishment
GRRP	groundwater replenishment reuse project
GWR	groundwater recharge
H_2O_2	hydrogen peroxide
HOCl	hypochlorous acid
IAP	Independent Advisory Panel
IND	industrial service water supplies
IPR	indirect potable reuse
L	liter(s)
LASAN	Los Angeles Bureau of Sanitation
LACSD	Los Angeles County Sanitation District
LRV	log removal value
Master Plan	Countywide Water Reuse Master Plan
MCL	maximum contaminant level
MF	microfiltration
mg	milligram(s)
mg/L	milligrams per liter
mgd	million gallons per day
mg-min	milligram-minutes
MIGR	Fish migration
mL	milliliters
MPN	most probable number
MRP	Monitoring and Reporting Program
MUN	municipal and domestic supply
N	nitrogen
NAV	Navigation
NEPA	National Environmental Policy Act
NL	notifications level
NO_3	nitrate
NOA	Notice of Applicability
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NWRI	National Water Research Institute
O&M	operations and maintenance
OCWD	Orange County Water District
Padre Dam	Padre Dam Municipal Water District
PCB	polychlorinated biphenyl
Plan	Operations and Management Plan
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
PR	potable reuse
PROC	process water supply
Q	flow
QMRA	quantitative microbiological risk assessment
RARE	Preservation of rare and endangered species
REC-1	Water contact recreation
REC-2	Non-contact water recreation
Regional Board	Regional Water Quality Control Board
RO	reverse osmosis
RWA	raw water augmentation
RWC	recycled water contribution
RWF	regional wastewater facility
RWQCP	Regional Water Quality Control Plant
SAP	Science Advisory Panel
SAT	soil aquifer treatment
SB	California Senate Bill
SBSPRP	South Bay Salt Pond Restoration Project
SCRWA	South County Regional Wastewater Authority
SF	San Francisco
SFB	San Francisco Bay
SFPUC	San Francisco Public Utilities Commission
SHELL	Shellfish harvesting
SIP	State Implementation Policy
SMCL	secondary maximum contaminant level
SNMP	Salt and Nutrient Management Plan
SPWN	Fish spawning
SRF	State Revolving Fund
State Board	State Water Resources Control Board
SWA	surface water augmentation
t	retention time
TDS	total dissolved solids
Thermal Plan	Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California
TMDL	Total Maximum Daily Load
TMF	technical, managerial, and financial
TOC	total organic carbon
TSS	total suspended solids
TWA	treated water augmentation
UDS	Undisinfected secondary recycled water
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
V	volume
V/G/C	virus, *Giardia, Cryptosporidium*
WARM	Warm freshwater habitat
WDR	waste discharge requirement
WILD	wildlife habitat
WPCP	Donald M. Somers Water Pollution Control Plant
WRR	water reclamation requirement
WWTP	wastewater treatment plant

Section 1: Overview of Water Reuse Policy in California

This section of the technical memorandum presents a brief history and overview of water reuse policy in California, including relevant regulations, regulatory agencies' responsibilities, recycled water in Santa Clara County, and recycled water regulatory structure.

1.1 History and Relevant Regulations

For more than a century, California has been effectively using recycled water as a non-potable water supply. As freshwater demand exceeds supply, recycled water is a highly attractive water supply option. For several decades, recycled water has been used for agricultural and landscape irrigation, groundwater recharge (GWR) (indirect potable reuse [IPR]), environmental and recreation enhancement, industrial applications and cooling, and to prevent seawater intrusion. Planned IPR by GWR of potable aquifers has been practiced in the state as early as 1953. California has been, and continues to be, a leader in water reuse.

California law has provided that the State's interest in conservation of water resources requires the maximum reuse of treated wastewater (Water Reuse Law, Water Code Sections 461–465). The California Water Code (CWC) is the principal State regulation governing the use of water resources within the state of California. This law controls and impacts water rights, development, and use of state water resources; water quality protection and management; management of water-oriented agencies; and applicable water reclamation requirements (WRR). The Porter-Cologne Water Quality Control Act (Porter-Cologne Act), which was the precursor to the federal Clean Water Act of 1972, is a prominent part of the CWC and serves as the State's comprehensive program for the protection of water quality and the beneficial uses of water.

The CWC provides that the State should encourage Californians to develop water recycling to meet the State's water needs and augment surface water and groundwater supplies (Water Reclamation Law, CWC Sections 13500–13556). California has steadily increased its use of recycled water since 1991, when the California Water Reclamation Act (CWC Section 13577) set water recycling goals. Revised recycled water targets were adopted in 2009 with the implementation of the State Water Resources Control Board's (State Board) Recycled Water Policy, which set a goal to increase the annual use of recycled water over 2002 levels by at least 1 million acre-feet by 2020 and at least 2 million acre-feet by 2030. The California Legislature continues to make progress in overcoming the institutional obstacles to water recycling, with the State Board developing standards for potable reuse (PR) for GWR and surface water augmentation (SWA), and a goal of establishing uniform criteria for direct potable reuse (DPR) by 2023. In addition, periodic drought has spurred increased attention to recycled water as a readily available resource, and public acceptance for its use continues to grow.

1.2 Regulatory Agencies' Responsibilities

The regulatory agencies with primary responsibility for regulating recycled water in California are the State Board and the nine Regional Water Quality Control Boards (Regional Board), which were created by the Porter-Cologne Act.

1.2.1 State Water Resources Control Board

The State Board is responsible for setting statewide water quality policy and WRRs. The State Board's Division of Drinking Water (DDW, formerly California Department of Public Health [CDPH]) has statutory authority in two areas with respect to recycled water reuse. It regulates public water systems in accordance with the California Safe Drinking Water Act (Health and Safety Code Section 116270 et seq.), and develops and adopts water recycling criteria as required by Section 13521 of the CWC. DDW does not have enforcement authority for water recycling criteria; they are enforced through permit systems administered by the nine Regional Boards under the overall authority of the State Board.

1.2.2 Regional Water Quality Control Boards

The nine Regional Boards implement water quality planning and regulatory decisions for their specific regions. The Regional Boards issue waste discharge requirements (WDR) (i.e., discharge permits) and administer National Pollutant Discharge Elimination System (NPDES) permits. The Regional Boards regulate discharges under the Porter-Cologne Act primarily through the issuance of WDRs, with the CWC providing enforcement through cease and desist orders, cleanup and abatement orders, administrative civil liability orders, civil court actions, and criminal prosecution. Specific regulatory responsibilities affecting water reuse include:

- Approving pollutant source control programs for wastewater systems
- Issuing and enforcing WRRs to producers and users of recycled water
- Defining beneficial uses of surface water and groundwater bodies by establishing water quality control plans
- Regulating operators of water reclamation treatment plants
- Making water rights determinations regarding water reclamation

All persons who recycle or propose to recycle water, and who use or propose to use recycled water, must file a report with the appropriate Regional Board (CWC Section 13522.5). If a Regional Board determines that it is necessary to protect public health, safety, or welfare, it may prescribe WRRs where recycled water is used or proposed to be used (CWC Section 13523). The Regional Board must consult with and consider recommendations of DDW when issuing WDRs/WRRs (CWC Section 13523).

1.3 Recycled Water in Santa Clara County

Water reuse is an expanding source of water for Santa Clara County. Water reuse augments drinking water and groundwater supplies through in-lieu recharge; provides a reliable, drought-resistant, locally controlled water supply; and reduces reliance on imported water. In 2016, recycled water accounted for approximately 5 percent (about 20,000 acre-feet per year [AFY]) of the county's total water supply, being distributed for non-potable water uses such as landscape and agricultural irrigation, industrial cooling, and dual-plumbed facilities. Recycled water is produced at the four wastewater treatment plants (WWTP) in the county:

- Palo Alto Regional Water Quality Control Plant (RWQCP)
- San José/Santa Clara Regional Wastewater Facility (RWF)
- South County Regional Wastewater Authority (SCRWA) WWTP
- Sunnyvale's Donald M. Somers Water Pollution Control Plant (WPCP)

In 2015, the Santa Clara Valley Water District (Valley Water) began a water supply planning process to develop at least 24,000 AFY, and up to 45,000 AFY, of PR capacity. Subsequently, the *Countywide Water Reuse Master Plan* (Master Plan) will outline Valley Water's approach to achieving its target that recycled water, including both non-potable reuse (NPR) and PR, constitute 10 percent of the county's water supply by 2025.

1.4 Recycled Water Regulatory Structure

The goal of this document is to describe the key regulations applicable to both NPR and PR. In general, the regulations fall under two categories: (1) public health protection criteria, and (2) environmental discharge criteria. Public health protection criteria generally include requirements for treatment, monitoring, and effluent water quality for the designated end use (e.g., landscape irrigation and groundwater recharge). Environmental discharge criteria consist of water quality requirements to protect surface water and groundwater quality for all designated beneficial uses. The sources of the criteria in Santa Clara County, as well as requirements for project implementation for the different types of reuse, are summarized in Table 1-1.

Table 1-1. Summary of Regulatory Criteria and Requirements for Water Reuse Applications in Santa Clara County

	Public Health Criteria	Environmental Discharge Criteria
Non-Potable Reuse		
Regulations	Recycled Water Policy [a] CCR Title 22, Division 4, Chapter 3	SFB and CC Basin Plans Salt and Nutrient Management Plans
Requirements	Approved Title 22 Engineering Report (State Board) Site-specific Water Recycling Requirements/Waste Discharge Requirements *or* Order 2016-0068-DDW Water Reclamation Requirements (Regional Board) Order R2-1996-0011	
Groundwater Recharge		
Regulations	Recycled Water Policy CCR Title 22, Division 4, Chapter 3	SFB and CC Basin Plans Salt and Nutrient Management Plans
Requirements	Approved Title 22 Engineering Report (State Board) Water Recycling Requirements (Regional Board) Waste Discharge Requirements (Regional Board)	
Surface Water Augmentation		
Regulations	CCR Title 22, Division 4, Chapter 3 CCR Title 22, Division 4, Chapter 17	SFB and CC Basin Plans California Toxics Rule Thermal Plan Order 2014-0194-DWQ CA Antidegradation Policy
Requirements	Approved Title 22 Engineering Report (State Board) Water Recycling Requirements (Regional Board) NPDES Permit containing Waste Discharge Requirements (Regional Board)	

a. *State Water Board Resolution 2009-0011.*

Public health protection criteria are developed by the State Board and contained in the California Code of Regulations (CCR) Title 22 Uniform Water Recycling Criteria (CDPH 2014). Specific criteria for each form of reuse are discussed in detail in the following sections. In general, these criteria are enforced through the use of WDRs, WRRs, or other appropriate permits issued by the Regional Board. These permits specify requirements for treatment, monitoring, reporting, effluent water quality, and any other elements of the water recycling criteria that are relevant for a given application. The Regional Boards generally ensure that reuse projects can meet the recycling criteria by requiring projects to receive State Board approval of a Title 22 Engineering Report to obtain a discharge permit.

Environmental discharge criteria can vary substantially depending on the specific discharge location and the type of reuse. In the northern portion of Santa Clara County, discharges are subject to the provisions of the Water Quality Control Plan for the San Francisco Bay Basin (SFB Basin Plan, while the Water Quality Control Plan for the Central Coast Basin (CC Basin Plan) covers discharges in the Llagas Subbasin south of Coyote Valley (Regional Board 2015). These and other relevant provisions are discussed in detail in the subsequent sections. In all cases, the criteria are based on protecting receiving waters (e.g., aquifers and reservoirs) to ensure that water quality is maintained for all beneficial uses. Environmental discharge criteria are enforced through a permit, and the type of permit depends on the receiving water. Discharges to aquifers, which are not considered waters of the United States, are governed by WDRs issued by the Regional Board. Discharges to reservoirs, on the other hand, require a permit under the NPDES program, which would also be issued by the Regional Board, along with WDRs specific to any state water quality policies and regulations.

The following sections provide detailed discussion of the public health and environmental discharge criteria for NPR, GWR, and SWA. Uniform water recycling criteria do not currently exist for DPR but are under development by DDW; the discussion of DPR focuses on public health protection elements that are likely to be included in the criteria.

Section 2: Non-potable Reuse

This section describes NPR, including approaches, a regulatory summary, and regulatory requirements.

2.1 Approaches

NPR is the beneficial reuse of recycled water in non-potable situations, such as irrigation for landscaping. Typically, recycled water is treated at a WWTP and sold to recycled water users through a separate distribution system, usually colored purple to distinguish it from the potable water distribution system.

The water quality requirements for the following four types of recycled water, listed in order of increasing water quality, are defined in the Uniform Statewide Recycling Criteria:

- Undisinfected secondary recycled water (UDS) (CCR, Title 22, Section 60301.900)
- Disinfected secondary-23 recycled water (DS23) (CCR, Title 22, Section 60301.225)
- Disinfected secondary-2.2 recycled water (DS2.2) (CCR, Title 22, Section 60301.220)
- Disinfected tertiary recycled water (DT) (CCR, Title 22, Section 60301.230)

Each category of recycled water has unique water quality requirements, which are discussed further in Section 2.3. The allowable end uses for non-potable recycled water are dictated by water quality, and range from strictly irrigation of landscaping to use in decorative fountains. A summary of typical end uses is presented in Table 2-1. Any use of recycled water that is not addressed in the Title 22 regulations is considered on a case-by-case basis by the Regional Boards (State Board 2016).

Table 2-1. Typical End Uses for Recycled Water

Category of Recycled Water	Typical End Uses
UDS	• Irrigation of non-food-bearing trees, seed crops not being consumed by humans, food and pasture for animals not producing milk for human consumption, and flushing of sanitary sewers
DS23	• All end uses of UDS • Irrigation of landscaping, including freeways, golf courses, and sod farms; use in industrial or commercial cooling that does not create a mist; industrial boilers; nonstructural firefighting; and cleaning of streets and outdoor work areas
DS2.2	• All end uses of UDS and DS23 • Irrigation of food crops, orchards, and vineyards not contacted by the recycled water; and use in fish hatcheries
DT	• All end uses of UDS, DS23, and DS2.2 • Irrigation of food crops where recycled water contacts the edible portion of the crop, parks, playgrounds, school yards, and residential landscaping; use in industrial or commercial cooling that does create a mist, flushing toilets, and decorative fountains

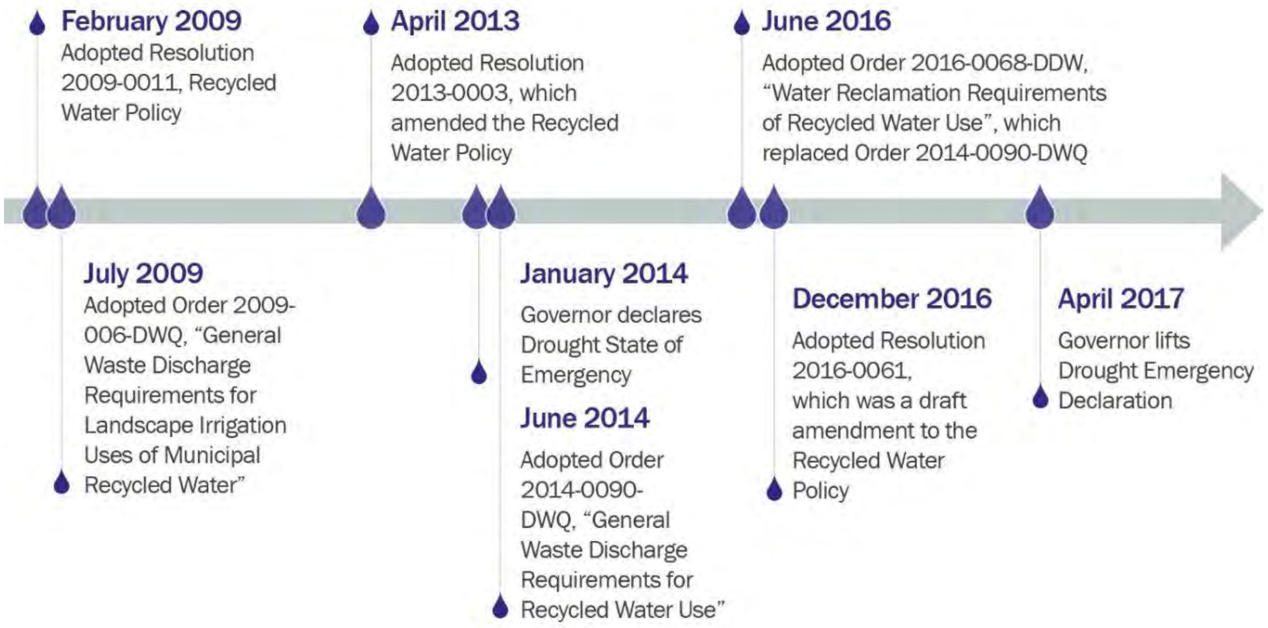
Source: Title 22 Water Recycling Criteria, adopted 7/16/2015.

Note: This is not intended to be a full list of allowable end uses of recycled water. Refer to the Title 22 regulations for the comprehensive list of end uses.

The four WWTPs within the scope of this study, which include the San José/Santa Clara RWF, Sunnyvale WPCP, Palo Alto RWQCP, and SCRWA WWTP, all currently produce disinfected tertiary recycled water for non-potable uses.

2.2 Regulatory Summary

Recycled water for NPR is carefully regulated, but is considered a traditional application of recycled water and has a relatively straightforward permitting process. The major recycled water regulations applicable to NPR are shown in Figure 2-1 and described below.



February 2009
Adopted Resolution 2009-0011, Recycled Water Policy

July 2009
Adopted Order 2009-006-DWQ, "General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water"

April 2013
Adopted Resolution 2013-0003, which amended the Recycled Water Policy

January 2014
Governor declares Drought State of Emergency

June 2014
Adopted Order 2014-0090-DWQ, "General Waste Discharge Requirements for Recycled Water Use"

June 2016
Adopted Order 2016-0068-DDW, "Water Reclamation Requirements of Recycled Water Use", which replaced Order 2014-0090-DWQ

December 2016
Adopted Resolution 2016-0061, which was a draft amendment to the Recycled Water Policy

April 2017
Governor lifts Drought Emergency Declaration

Figure 2-1. California recycled water regulations have been streamlined to support the development of NPR projects

California Title 22 Regulations. California regulates the treatment, use, and discharge of recycled water according to Title 22 of the CCR. Title 22 covers environmental health, which includes water-related issues. Chapter 3 within Title 22 covers all recycled water quality standards and appropriate end uses, which are described below in Sections 2.2 and 2.3.

Recycled Water Policy (created in 2009 and amended in 2013 and 2018). The State Board first developed the Recycled Water Policy to expedite implementation of projects using municipal recycled water for landscape irrigation and meeting regulatory requirements for treatment level and use area restrictions as prescribed by Title 22 in 2009. It was amended in 2013 to add contaminants of emerging concern (CEC) monitoring requirements for potable reuse projects, which came from a Science Advisory Panel (SAP) on CECs. The Recycled Water Policy streamlines the permitting process for landscape irrigation recycled water projects through a general permit. Salt and nutrient management planning is also a key requirement to assist in streamlined permitting.

In April 2018, a new report of the SAP was released, "Monitoring Strategies for Constituents of Emerging Concern in Recycled Water." The Recycled Water Policy incorporates the SAP recommendations for potable reuse projects, notably two new bioassay monitoring requirements. An amendment adopted in December 2018 (and made effective on April 8, 2019) incorporates regulatory developments that have taken place since the policy was last amended in 2013, as well as recommendations of the SAP.

General Orders for Non-Potable Reuse of Municipal Recycled Water. General Orders are used by the State and Regional Boards to streamline permitting for reuse projects. Permitting under a General Order requires that projects comply with all relevant requirements of Title 22. Additional requirements are specific within each General Order.

- **Order 96-011. "General Reuse Requirements for Municipal Wastewater and Water Agencies" (1996).** This Order was issued by the California Regional Water Quality Control Board, SFB Region. This General Water Reuse Order authorized municipal wastewater reuse of NPR throughout the region. It streamlined the permitting process (replacing individual reuse orders) and delegated the responsibility of administrating water reuse programs to local agencies. A separate NPDES permit is required to use ephemeral or year-round streams or other waters of the State for recycled water conveyance or direct or indirect groundwater recharge,
- **Order 2009-0006-DWQ "General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water" (July 2009).** This General Order updated the regulatory process for landscape irrigation uses of recycled water. Most recycled water irrigation of landscaping at parks, greenbelts, playgrounds, school yards, athletic fields, golf courses, cemeteries, residential common areas, commercial and industrial areas, and along freeways, highways, and streets are eligible for coverage.
- **Order 2014-0090-DWQ "General Waste Discharge Requirements for Recycled Water Use" (June 2014).** This General Order was adopted in response to a Drought State of Emergency proclaimed on January 17, 2014, by California's governor. This General Order established standard conditions for recycled water use and conditionally delegated authority to an administrator to manage a Water Recycling Program and issue Water Recycling Permits to recycled water users. Only treated municipal wastewater for non-potable uses can be permitted, including landscape irrigation, crop irrigation, dust control, industrial/commercial cooling, and decorative fountains. This General Order also mandates the submission of a Title 22 Engineering Report as well as technical reports for the Notice of Intent (NOI) and Monitoring and Reporting Program (MRP) (Section 2.3) to ensure compliance and satisfy Water Code 13267 requirements.

- **Order 2016-0068-DDW "Water Reclamation Requirements for Recycled Water Use" (June 2016).** The State Board adopted Order 2016-0068-DDW to replace the existing statewide Waste Discharge Requirements for Recycled Water Use (2014-0090-DWQ). This General Order is intended to further encourage recycled water projects by (1) acknowledging recycled water as a resource and (2) allowing recycled water programs that are implemented in multiple Regional Board boundaries to be permitted by the State Board.

2.3 Regulatory Requirements

This section describes the regulatory requirements for the non-potable use of recycled water, including pertinent public health criteria, environmental criteria, and permitting criteria and requirements.

2.3.1 Public Heath Criteria

To maintain public health protection, the categories of recycled water have increasingly stringent water quality requirements as the potential for public exposure increases. These water quality criteria are described in Table 2-2.

Table 2-2. Water Quality Criteria for NPR

Category of Recycled Water	Definition and Water Quality Criteria
UDS	Wastewater in which the organic matter has been stabilized, is non-putrescible, and contains dissolved oxygen (CCR, Title 22, §60301.900 and 650)
DS23	Recycled water that has been oxidized and disinfected so that: • Median concentration of total coliform bacteria no greater than a most probable number (MPN) of 23 per 100 milliliters (mL) and total coliform bacteria no more than an MPN of 240 per 100 mL (CCR, Title 22, §60301.225)
DS2.2	Recycled water that has been oxidized and disinfected so that: • Median concentration of total coliform bacteria is no greater than an MPN of 2.2 per 100 mL and the number of total coliform bacteria is no more than an MPN of 23 per 100 mL (CCR, Title 22, §60301.220)

DT	A filtered and disinfected water that meets the following criteria:
	• Filtered wastewater has been disinfected by either of the following:
	  • A chlorine disinfection process that provides a CT (concentration x contact time) value of no less than 450 milligram-minutes (mg-min) per liter (L) always with a modal contact time of no less than 90 minutes
	  • A disinfection process that is demonstrated to inactivate and/or remove 99.999% of the plaque-forming units of F-specific bacteriophage MS2 or polio virus
	• And median concentration of total coliform bacteria no more than an MPN of 2.2 per 100 mL and the number of total coliform bacteria does not exceed an MPN of 23 per 100 mL in more than one sample in a 30-day period and no sample shall exceed an MPN of 240 total coliform bacteria per 100 mL (CCR, Title 22, §60301.230)

Source: Title 22 Water Recycling Criteria, adopted 7/16/2015.

Note: This is a summarized version of the water quality criteria for recycled water. Refer to the referenced sections with Title 22 for the full water quality criteria.

2.3.2 Environmental Criteria

While recycled water is not discharged directly into groundwater or surface water, it is important to consider the potential impact on groundwater through percolation and surface water through runoff. Environmental criteria for recycled water are governed by General Order WQ 2016-0068-DDW here under the SFB Regional Board, the *San Francisco Bay Basin Plan,* and the CC Regional Board, *Central Coastal Basin Plan*. They are also governed by pertinent Salt and Nutrient Management Plan (SNMP) requirements.

2.3.2.1 Order 2016-0068-DDW, Water Reclamation Requirements

The General Order states that “recycled water use shall not cause unacceptable groundwater and/or surface water degradation,” which is mitigated by storing recycled water in unlined ponds (although the applicant would have to line the pond if required by the Regional Board), limiting the application of recycled water to agronomic rates, and controlling the use of recycled water to prevent significant runoff (State Board 2016). The General Order also states that “recycled water shall not create nuisance conditions,” which is accomplished by requiring wastewater to be oxidized, preventing airborne spray from entering dwellings, and prohibiting the application of recycled water to saturated soil (State Board 2016).

2.3.2.2 California Water Code Sections 1210-1212, Wastewater Effluent Water Rights

Sections 1210, 1211, and 1212 of the Water Code explicitly address ownership and water rights with respect to treated wastewater. If a water reuse project will decrease the amount of water in a stream or other waterway, the owner of the wastewater treatment plant needs to file a wastewater change petition with the Division of Water Rights. A petition is not needed for changes in the discharge or use of treated wastewater that do not result in decreasing the flow in any portion of a watercourse, or when the discharge is directly to the ocean or a bay.

2.3.2.3 Basin Plan Criteria

The General Order requires recycled water uses to comply with the applicable Basin Plan, which determines beneficial uses of groundwater and surface waters in Santa Clara County. The Basin Plan also includes water quality criteria to help maintain and support those identified beneficial uses. Thus, determination of compliance with the Basin Plan is part of the application process for NPR.

Some examples of the beneficial uses for groundwater and surface waters in Santa Clara County include municipal and domestic supply (MUN), agricultural supply (AGR), industrial process water supply (PROC), and industrial service water supplies (IND). The water quality standards to help maintain the identified beneficial uses for groundwater and surface waters are described in Section 3.2.3.1 and Section 3.3.3.1, respectively.

2.3.2.4 Salt and Nutrient Management Plan Criteria

The General Order considers that, while the use of recycled water for irrigation is not expected to be a significant source of salt loading relative to other sources, it may have the potential to increase salts and other contaminants in groundwater. Thus, it references the Recycled Water Policy, which calls on local water and wastewater utilities to fund and develop SNMPs. The pertinent water quality objectives specific to Santa Clara County are detailed in Chapter 3 of the *San Francisco Bay Basin Plan,* and Chapter 3 of the *Central Coastal Basin Plan*.

2.3.2.5 NPR Use Area Requirements

To support protection of the environment, NPR use area requirements are included in the Title 22 regulations, in Chapter 3, Article 4, “Use Area Requirements.” End users of recycled water must understand these requirements and ensure compliance.

2.3.3 Permitting Approaches

Permitting for NPR projects involves obtaining WDRs and/or WRRs. Currently, the most straightforward approach to permitting new NPR projects is to leverage General Order 2016-0068-DDW. Existing NPR projects that were permitted under previous General Orders will not be impacted by this General Order. This section describes the process for those existing projects and outlines the permitting process for new NPR projects.

2.3.3.1 Existing Projects Under Previous General Orders

The purpose of General Order 2016-0068-DDW is to provide consistent regulation of non-potable uses of recycled water statewide. To provide this consistency, the General Order intended that existing Regional Board general orders or conditional waivers for NPR be terminated by the Regional Board within 3 years of the adoption of the General Order (i.e., by June 2019).

2.3.3.2 Baseline Approach for New Projects

New NPR projects that are seeking a permit under the 2016 General Order must complete the application process, which includes submitting an NOI and Title 22 Engineering Report as described in Attachment A of the General Order.

The NOI must include the following information:

- Facility or waste treatment information.
- Proposed application of recycled water, including estimated amount of water to be used, use type and use area, and a proposed Implementation Plan or Operations and Management Plan. The plan should include specific agronomic rates and nutrient application for the use area(s).
- Description of water recycling program.
- Any additional site-specific conditions.
- Description of water recycling program administration.

The application must also include a Title 22 Engineering Report, and approval of the report must be obtained from the State Board before the Regional Board issues the permit.

Other potentially applicable permits for the permitting process include California Environmental Quality Act (CEQA), CEQA-Plus, and National Environmental Policy Act (NEPA) (as applicable). Any request for modification of existing WDRs must also be reviewed and approved by the appropriate Regional Board.

2.3.3.3 Alternative Approach for New Projects

New NPR projects can apply to the Regional Board for a site-specific order. This option would be needed if the proposed discharge is not consistent with the Basin Plan requirements or any other requirement specified in the 2016 General Order.

2.3.3.4 Monitoring and Reporting Requirements

Monitoring and reporting requirements are described in Attachment B of the 2016 General Order (MRP) and in the Title 22 regulations. The MRP describes the requirements for monitoring a recycled water system. Not all of the monitoring requirements listed may be required of all recycled water projects, and Regional Board staff can be consulted to determine the applicable requirements. The monitoring requirements listed in the 2016 General Order are summarized in Table 2-3.

Table 2-3. Monitoring Requirements for NPR (per 2016 General Order)		
Type of Monitoring	When Applicable	Monitored Constituent(s), Parameter(s), and/or Requirement(s)
Recycled water monitoring	If recycled water is used for irrigation of landscape areas	• Priority pollutants
Disinfection system monitoring	If disinfection is performed	• Total coliform bacteria [a] • Turbidity [a]
Pond system monitoring	If recycled water storage ponds are used to store recycled water when not needed	• Freeboard • Odors • Berm condition
Use area monitoring	Administrator shall monitor use area(s), which may be delegated to a user; however, reporting responsibilities remain with the administrator	• Recycled water user • Recycled water flow • Acreage applied • Application rate • Soil saturation/ponding • Nuisance odors/vectors • Discharge offsite • Notification signs
Cooling/industrial/other uses of recycled water	If recycled water is used for industrial, commercial cooling, or air conditioning where mist is generated	• Comply with CCR, Title 22, §60306 (c)
Dual-plumbed recycled water systems	If dual-plumbed recycled water systems are proposed	• Cross connection testing • Backflow incident • Backflow prevention device testing and maintenance

a. Reporting frequency for total coliform bacteria and turbidity is to be determined and specified within the NOA or as required by the CCR.

Title 22 regulations also mandate sampling requirements for NPR, which are required of the producer or supplier of the recycled water. These requirements are detailed in Title 22, Chapter 3, Article 6, "Sampling and Analysis" and summarized in Table 2-4.

Table 2-4. Sampling Requirements for NPR (per Title 22)	
Category of Recycled Water	Sampling and Analysis Requirements
UDS	n/a
DS23	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3.
DS2.2	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3.
DT	Sampled at least once daily for total coliform bacteria to meet water quality requirements described in Table 3. Shall be continuously sampled for turbidity by using a continuous meter following filtration to ensure compliance with water quality requirements described in Table 2. • Compliance with daily average operating filter effluent turbidity shall be determined by averaging the levels of recorded turbidity taken at 4-hour intervals over a 24-hour period • Should the continuous turbidity meter fail, grab sampling at a minimum frequency of 1.2 hours may be substituted for a period of up to 24 hours The results of the daily average turbidity shall be reported quarterly to the regulatory agency.

The administrator of the recycled water program is required to submit an Annual Report to the Regional Board by April 1 following the monitoring year. The requirements of the Annual Report are described in Attachment B of the 2016 General Order.

Section 3: Potable Reuse

This section describes PR, including approaches, groundwater recharge regulatory requirements, surface water augmentation regulatory requirements, and DPR.

3.1 Approaches

PR applications exist along a spectrum based on the distance and time of treatment to purified water levels and its ultimate consumption by the public. IPR is characterized by the use of an environmental buffer.

DPR projects are defined by the absence of a significant environmental buffer. California distinguishes two forms of DPR: raw water augmentation (RWA) and treated water augmentation (TWA). Because they do not incorporate environmental buffers, DPR projects will have significantly reduced time to detect and respond to failures or compromises in treatment prior to distribution. As this response time decreases and projects become more direct, different strategies are needed to ensure public health protection.

Generally, as the forms of reuse become more direct, the regulations require higher levels of treatment. In principle, this is to compensate for the protections that are lost by the water spending less time in the environment. This concept is depicted in Figure 3-1, where the level of treatment increases moving from GWR through spreading to TWA. The minimum level of treatment is tertiary filtration and disinfection, and grows with increasing degrees of rigor from groundwater injection to SWA. Both GWR and SWA require full advanced treatment (FAT), which is treatment of the entire flow of water through both reverse osmosis (RO) and an advanced oxidation process (AOP). Given this trend toward higher treatment with greater directness, it is likely that future RWA and TWA regulations will also specify additional treatment beyond the IPR requirements (Olivieri et al. 2016; State Board 2018).

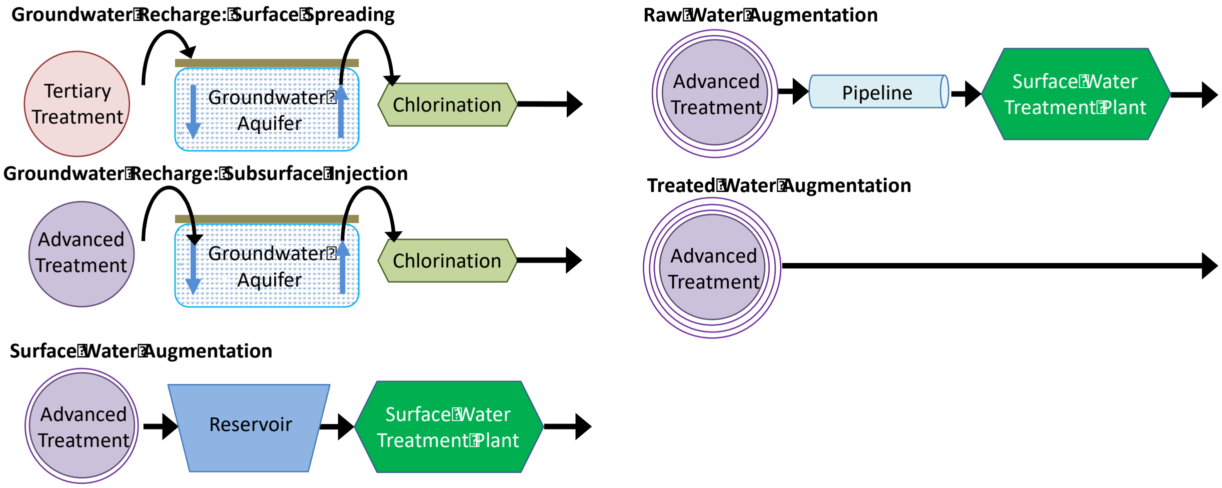

Groundwater Recharge: Surface Spreading
Tertiary Treatment
Groundwater Aquifer
Chlorination
Groundwater Recharge: Subsurface Injection
Advanced Treatment
Groundwater Aquifer
Chlorination
Surface Water Augmentation
Advanced Treatment
Reservoir
Surface Water Treatment Plant
Raw Water Augmentation
Advanced Treatment
Pipeline
Surface Water Treatment Plant
Treated Water Augmentation
Advanced Treatment

Figure 3-1. Forms of potable reuse in California

The following sections describe the regulatory requirements for the various forms of PR, including both the public health and environmental requirements. While containing many prescriptive requirements, the regulations do incorporate a certain degree of flexibility. This flexibility has been and can be used to pursue novel approaches that offer advantages in terms of project size and overall cost. Each section concludes with a discussion of this regulatory flexibility, and provides examples of the variety of permitting approaches based on existing and planned California projects.

3.2 Groundwater Recharge Regulatory Requirements

This section describes PR groundwater recharge regulatory requirements, including a regulatory summary, public health criteria, environmental criteria, and permitting approaches.

3.2.1 Regulatory Summary

The surface spreading GWR project at Los Angeles County Sanitation District's (LACSD) Montebello Forebay was the first PR project in California. Fourteen years after this project began (1962), the first draft regulations governing GWR were released (California Department of Health Services 1976). A year later, Water Factory 21 at Orange County Water District (OCWD) became the first subsurface injection GWR project. These two pioneering projects were instrumental in helping regulators understand the risks and control tools needed for reliable, safe PR, and played a large role in shaping the final GWR regulations, which were published in June 2014 (CDPH 2014). The adoption of the final regulations in 2014 was significant in that it provided clear and defined regulatory guidance for agencies interested in GWR. The completion of this regulation was motivated by California Senate Bill (SB) 918, which mandated the finalization of the GWR regulations by December 2013.

The regulations identify two forms of GWR: surface spreading (Title 22, Chapter 3, Article 5.1; Figure) and subsurface injection (Title 22, Chapter 3, Article 5.2). Surface spreading requires that secondary effluents receive a minimum of tertiary filtration and disinfection prior to application of the water to a spreading basin (CDPH 2014). As water percolates through the soil to the aquifer, further control and attenuation of contaminants is provided through soil aquifer treatment (SAT).

Subsurface (or direct) injection projects introduce water directly into the aquifer, and thereby bypass the potential for further treatment through SAT. Accordingly, higher degrees of treatment are required at advanced water treatment facilities (AWTF) to ensure that equivalent qualities of water are extracted and distributed.

The following section describes the key considerations for these two forms of GWR in terms of both public health and environmental protection.

3.2.2 Public Health Criteria

Because the requirements differ for surface spreading and subsurface injection projects, they are divided into two articles: Article 5.1 for Surface Application and Article 5.2 for Subsurface Application (CDPH 2014). Generally, the types of requirements are similar, though the specific details may differ. The major requirements for the two forms of GWR are described in the following sections, with emphasis added to areas in which they differ.

3.2.2.1 Pathogenic Microorganism Control

The public health aspects of the GWR regulations focus first and foremost on minimizing the acute risk of pathogenic microorganisms. Requirements for pathogen control include 12-log reduction of enteric virus, 10-log reduction of *Giardia* cysts, and 10-log reduction of *Cryptosporidium* oocysts. These "12/10/10" requirements must be met using a multiple-barrier approach—for each type of pathogen, a minimum of three treatment processes must be used, with each providing at least 1.0-log, but credited with no more than 6.0-logs, of pathogen removal credit.

For spreading applications (Figure 3-2), the minimum water quality that can be used for recharge is a filtered, disinfected tertiary recycled water (see Section 2.1). Higher levels of treatment—e.g., FAT—could be used for spreading; however, FAT is not necessary for spreading projects. Any spreading project that provides a minimum of 6 months of retention time is credited with 10-log reduction of both *Cryptosporidium* and *Giardia* (Section 60320.108.c). Furthermore, one log of virus credit is assigned per month of retention time in the aquifer.

Figure 3-2. Montebello Forebay groundwater recharge spreading basins in Los Angeles County

For subsurface injection, credit for *Giardia* cysts and *Cryptosporidium* oocysts cannot be achieved through aquifer retention time. Consequently, the full log removal requirement for *Giardia* cysts and *Cryptosporidium* oocysts must be accomplished prior to injection. As with spreading projects, virus removal can be accomplished through a combination of treatment at the AWTF and subsurface attenuation. In every case, demonstration of performance or retention time must be provided. For treatment processes used to meet pathogen requirements, projects must validate unit process performance and demonstrate their effectiveness via ongoing monitoring of a surrogate parameter. Furthermore, the retention time underground must be verified using a tracer study under hydraulic conditions representative of normal GWR operations.

3.2.2.2 Advanced Treatment Criteria

One key differentiator between the two forms of reuse is the minimum degree of treatment required. Spreading projects must meet only the Title 22 requirements for disinfected tertiary waters (i.e., oxidation, filtration, and disinfection) given that additional treatment is provided via SAT at the spreading basin. Because groundwater injection does not benefit from SAT, higher degrees of treatment are required at the AWTF. Specifically, groundwater injection requires the use of FAT, or the treatment of the entire flow of water with RO and an oxidation treatment process (Section 60320.201). Most FAT facilities follow the GWR treatment train model using microfiltration (MF), RO, and advanced oxidation via ultraviolet (UV)/hydrogen peroxide (H_2O_2) or UV-hypochlorous acid (HOCl). Because the treatment requirements for subsurface injection are more stringent than surface spreading, water that has been treated through a FAT train can be used for both injection and spreading.

Performance requirements for RO (Figure 3-3) involve demonstrating minimum levels of salt rejection and ensuring that permeate total organic carbon (TOC) remains within specified limits. Initially, RO was considered an absolute barrier to pathogens and chemicals; however, with improving analytical methods, trace organic compounds have been detected in RO permeate. This recognition gave rise to the requirement for an AOP following RO. To demonstrate AOP performance, the regulations allow one of two methods to be used. In the first, AOP must be demonstrated to provide minimum removals of a suite of constituents from nine different chemical classes (Section 60320.201.c). The second, and more commonly pursued option, is to demonstrate the ability of AOP to provide 0.5-log reduction of 1,4-Dioxane (CDPH 2014). 1,4-Dioxane was selected because it serves as an indicator of the low molecular weight, uncharged constituents that have been shown to pass through RO; processes that reduce 1,4-Dioxane levels (e.g., AOPs) will also be effective at removing a wide diversity of additional CECs.

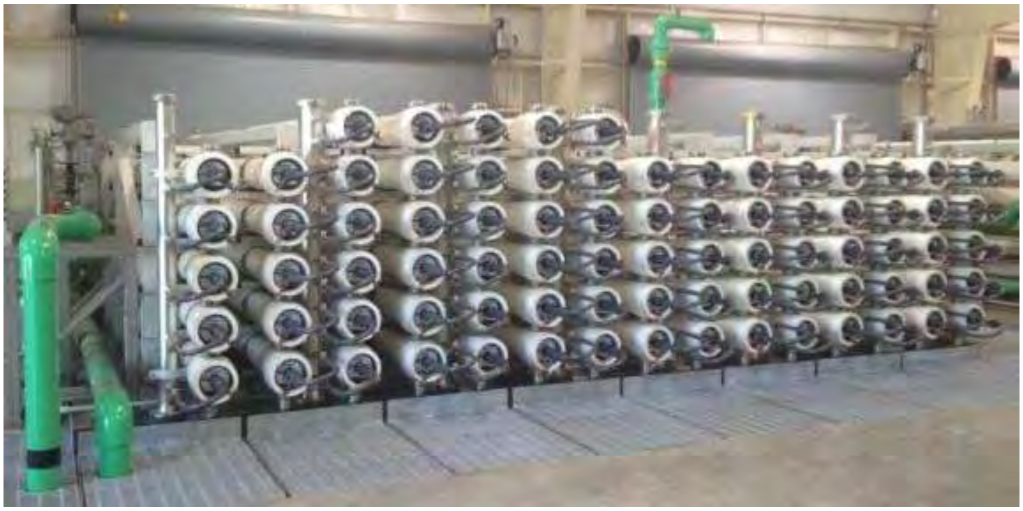


Figure 3-3. Reverse osmosis treatment skid at the Silicon Valley Advanced Water Purification Center

3.2.2.3 Source Control

The recycled water used for GWR projects must be from a wastewater management agency that administers an industrial pretreatment and pollutant source control program. The program must include (1) an assessment of the fate of site-specific chemicals through the wastewater and recycled water treatment systems, (2) monitoring and investigation of chemical sources, (3) an outreach program to manage and minimize the discharge of chemicals into the source water, and (4) an inventory of chemicals that may be discharged into the wastewater collection system.

3.2.2.4 Chemical Control

Chronic and acute risks to public health associated with chemical contaminants are also addressed in the GWR regulations, including nitrogen (N) compounds (Sections 60320.110 and 60320.210), regulated contaminants (Sections 60320.112 and 60320.212), and additional chemical and contaminant monitoring, including various unregulated contaminants (Sections 60320.120 and 60320.220). Total nitrogen must be sampled twice weekly with any exceedances above 10 milligrams per liter (mg/L) as N requiring additional action. As with many constituents, samples can be taken either before or after surface application, i.e., after taking advantage of SAT. Reduced monitoring is possible for projects that show consistently low levels over a 24-month period.

Regulated contaminants—including inorganics, radionuclides, organic chemicals, disinfection by-products (DBP), and lead and copper—must be monitored quarterly. Constituents with secondary maximum contaminant levels (SMCL) must be measured at least once annually. Actions to take in the event of exceedances are also described.

The additional chemical and contaminant monitoring requirements include (1) the priority toxic pollutants, (2) a list of site-specific, unregulated chemicals that must be determined in conjunction with the State Board, and (3) constituents with notifications levels (NL). The State Board has enlisted a Science Advisory Panel to help develop the list of unregulated contaminants for monitoring. The most recent recommendations were provided in its April 2018 report titled *Monitoring Strategies for Constituents of Emerging Concern in Recycled Water* (Drewes et al. 2018).

3.2.2.5 Diluent Water and Recycled Wastewater Contribution

Many spreading projects will require dilution with other waters (diluent water) to meet the water quality requirements of the regulations (particularly spreading projects that do not use FAT). The criterion for determining the amount of diluent water required is TOC; ultimately, no more than 0.5 mg/L of TOC from the recycled water may be present in the blended groundwater. The regulations specify minimum water quality requirements for diluent water, and also require that sponsors develop a method to demonstrate the volume of diluent water provided.

The TOC of the recycled water sets the maximum percentage of recycled water that can be blended into the groundwater. The formula for the maximum recycled water contribution (RWC) is:

$$Recycled\ water\ contribution\ (RWC) = \frac{0.5\ mg/L}{TOC\ in\ recycled\ water\ (in\ \frac{mg}{L})}$$

If a recycled water has a TOC of 2.5 mg/L, for example, the maximum RWC would be 0.5 mg/L divided by 2.5 mg/L, or 20 percent. Such a project would need to provide diluent water to constitute the remaining 80 percent of the total water. The initial RWC for SAT is no greater than 20 percent based on a running monthly average RWC using the total volume of recycled municipal wastewater and credited diluent water over the past 120 months. Provisions exist to increase RWC from this initial 20 percent, but levels exceeding 50 percent require special permission.

While RWC requirements are also present in the groundwater injection regulations (Section 60320.216), they are much less limiting for PR systems employing the FAT process. This is a consequence of the FAT requirement for RO treatment, which must continuously meet concentrations not exceeding 0.5 mg/L of TOC. Accordingly, FAT projects can typically comply with Section 60320.16.c, which allows for an initial maximum RWC of 1.0 (i.e., no dilution) because the project can reliably achieve TOC concentrations no greater than 0.5 mg/L.

3.2.2.6 Response Retention Time

Per Sections 60320.124 (spreading) and 60320.224 (injection), recycled water applied by a GWR project must be retained underground for a minimum of two months to allow a project sponsor sufficient response time to identify treatment failures and implement actions, including the plan to provide an alternative water supply or wellhead treatment. To demonstrate that the actual retention time underground is no less than that required, an added tracer or a DDW-approved intrinsic tracer must be used. For each month of retention time estimated using the approved intrinsic tracer, a project sponsor shall receive no more than 0.67-month credit. The actual retention time is the time representing the difference between when the water containing the tracer is applied and when either 2 percent of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10 percent of the peak tracer unit value arrives at the downgradient monitoring point.

For planning purposes, modeling may be used to estimate the retention time provided by an aquifer. For each month of retention time estimated using modeling, the recharge water may be credited with no more than either (1) 0.5-month credit for numerical modeling, or (2) 0.25-month credit for analytical modeling (as defined in Table 60320.124).

3.2.2.7 Alternatives

One aspect of the regulations that allows for flexibility in the aforementioned requirements is the alternatives clause (Sections 60320.130 and 60320.230). The clause offers broad freedom to use alternatives, as long as the alternatives (1) are demonstrated to be equally or more protective of public health, (2) receive written approval from DDW, and (3) have been discussed in a public hearing. To help DDW assess the alternatives, an independent advisory panel (IAP) is typically required to assess the public health protection that will be provided. The IAP must be composed of a toxicologist, geologist/hydrogeologist, an engineer with at least 3 years of experience in wastewater treatment and public drinking water supply, a microbiologist, and a chemist.

3.2.2.8 Other Criteria

The regulations for GWR through surface spreading and subsurface injection are different because of the loss of SAT when the water is injected directly. However, the major requirements designed to ensure high water quality and protection of public health are the same, and are summarized in Table 3-1.

Table 3-1. Summary of Additional Criteria for Groundwater Replenishment Reuse Applications

Requirement	Description
General requirements (§60320.100 and §60320.200)	Describes compliance report that must accompany all projects showing ability to meet the requirements of the regulation; specifies requirements for alternative water supplies, and aquifer water quality and hydrogeological characterization, including zone of controlled drinking water well construction; demonstration of technical, managerial, and financial (TMF) capabilities; approvals needed to recommence a project that has been suspended
Public hearing (§60320.102 and §60320.202)	Required for the initial permit and whenever there is a proposal to increase the maximum recycled municipal wastewater contribution
Laboratory analysis (§60320.104 and §60320.204)	Must be performed by certified labs approved by DDW using DDW-approved drinking water methods
Operations plan (§60320.122 and §60320.222)	Operation Optimization Plan must be submitted to DDW prior to startup that identifies and describes operations and maintenance (O&M), monitoring, and analytical methods for the groundwater replenishment reuse project (GRRP) to meet the requirements of the groundwater replenishment regulations
Reporting (§60320.128 and §60320.228)	Annual report must be submitted to DDW within 6 months of the end of each calendar year; engineering reports must be updated at least once every 5 years

3.2.3 Environmental Criteria

Recycled water discharges to groundwater in Santa Clara County are regulated by either the SFB Regional Board or the CC Regional Board. WDRs/WRRs for GWR will ensure compliance with the following regulations:

- All relevant articles from California Title 22, Chapter 3: Recycled Water Criteria
- Monitoring requirements for priority pollutants and CECs laid out in the Recycled Water Policy
- Water quality objectives identified in the SFB Basin Plan or the CC Basin Plan, as applicable (depending upon location)
- Water quality objectives and implementation policies established in Valley Water’s Groundwater Management Plan and the SNMPs for the Santa Clara and Llagas subbasins

Permit limits for groundwater replenishment projects are set to ensure that GWR project discharges do not adversely affect beneficial uses or degrade water quality. Criteria governing discharge water quality to the environment are contained in the Basin Plan and SNMPs.

3.2.3.1 Basin Plan Criteria

The SFB and CC Basin Plans identify both narrative and numeric objectives for groundwater; these objectives are supplemented with basin-specific and/or site-specific objectives as needed. The primary objective for the groundwater quality standards is to maintain the existing high quality of groundwater in the region.

The following standards are specified for beneficial use of the groundwater:

- Total coliform (MUN): 7-day median < 1.1 MPN)100 (mL (SFB Basin Plan) or < 2.2 MPN/100 mL (CC Basin Plan)
- Organic and inorganic chemicals (MUN): At a minimum, groundwater designated for use as domestic or municipal supply must comply with drinking water maximum contaminant levels (MCLs) and SMCLs established in the following provisions of Title 22: Table 64431-A of Section 64431 (inorganic chemicals), Table 64433.2-A of Section 64433.2 (fluoride), Table 64444-A of Section 64444 (organic chemicals), Tables 64449-A and 64449-B of Section 64449 (SMCLs: consumer acceptance limits)
- AGR: Additional water quality objectives are specified for agricultural use, including livestock watering. These are specified in Table 3-6 of each Basin Plan
- Radioactivity (MUN): At a minimum, groundwater designated for use as domestic or municipal supply must comply with drinking water MCLs and SMCLs established in the following provisions of Title 22: Table 64442 of Section 64442 and Table 64443 of Section 64443 (radionuclides)
- Taste and odor: Groundwater designated for MUN use must not contain taste- or odor-producing substances in concentrations that cause a nuisance or adversely affect beneficial uses

3.2.3.2 Salt and Nutrient Management Plan Criteria

The SNMPs for the Santa Clara and Llagas subbasins set basin-specific water quality objectives based on the objectives identified in the applicable Basin Plan. Water quality objectives for total dissolved solids (TDS), nitrate (NO_3), nitrite, and nitrate + nitrite are specified (Table 3-2).

Table 3-2. Salt and Nutrient Management Plan Water Quality Objectives for the Santa Clara and Llagas Subbasins (Regional Board, CC Region 2017; Regional Board, SFB Region 2017)

Parameter	Unit	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	
			Santa Clara Subbasin	Llagas Subbasin
TDS	mg/L	500	10,000	450
Nitrate	mg/L as NO_3	45	--	--
Nitrate and nitrite	mg/L as N	10	30	100 [a]
Nitrite	mg/L	--	--	10 [a]

a. For livestock watering.

Note: MUN objectives are the same for the both subbasins.

3.2.4 Permitting Approaches

This section describes permitting approaches to PR groundwater recharge regulatory requirements. For both spreading and injection, a baseline approach is described that entails meeting the standard requirements of the regulations (described above). Alternative permitting approaches are also described for both types of projects that would allow for larger project capacities; these are described here as “high-capacity” approaches. There are no separate regulations for high-capacity projects; however, these approaches use innovative strategies to go beyond the standard requirements of the regulations. A summary of the baseline and high-capacity approaches for both spreading and injection is provided in Figure 3-4; these approaches will be further discussed in the following sections.

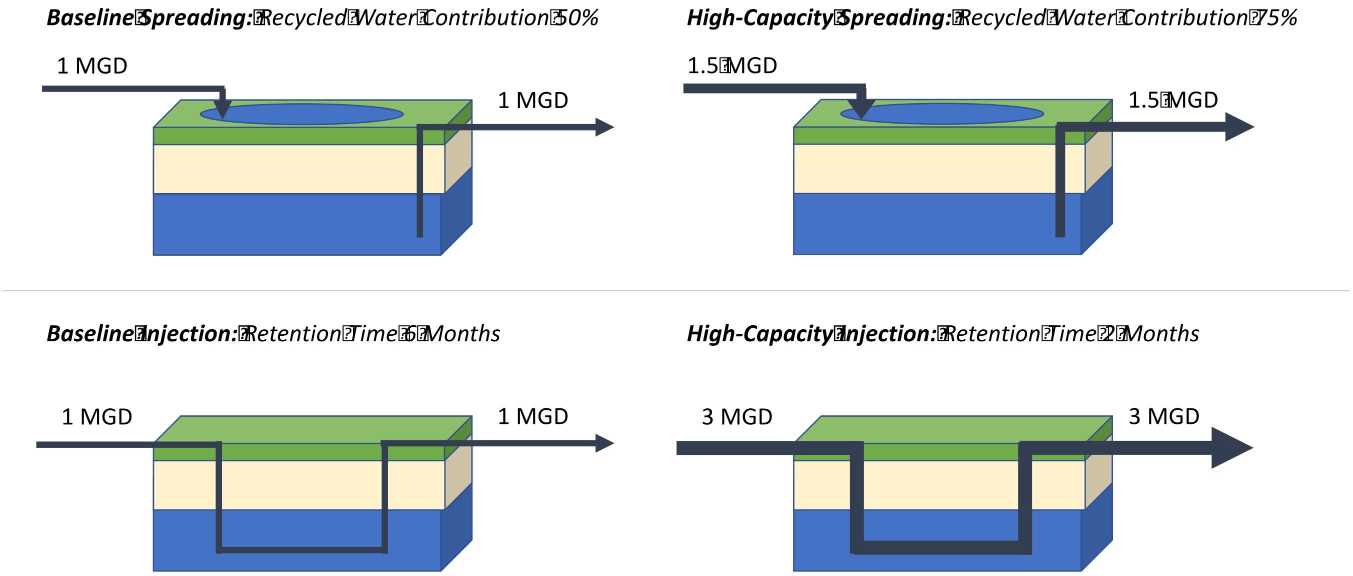

Baseline Spreading: Recycled Water Contribution 50%
1 MGD
1 MGD
High-Capacity Spreading: Recycled Water Contribution 75%
1.5 MGD
1.5 MGD
Baseline Injection: Retention Time 6 Months
1 MGD
1 MGD
High-Capacity Injection: Retention Time 2 Months
3 MGD
3 MGD

Figure 3-4. Summary of baseline and high-capacity permitting approaches for groundwater recharge via spreading and injection

All flow values are used solely as examples to illustrate the potential difference between baseline and high-capacity flows.

3.2.4.1 Baseline Approach

One of the hallmarks of the GWR regulations is the requirement for significant aquifer retention times. In addition to further treating the recycled water, the water’s passage through the aquifer provides time to respond to and correct any issues that may have occurred in upstream treatment. Accordingly, GWR projects are structured to both prevent failures from happening (through multiple elements including source control, treatment, monitoring, and operations), while also providing time to respond to failures were they to arise. Projects that provide a balanced mixture of both failure prevention (treatment, monitoring, etc.) and failure response (retention time) elements will likely be the easiest to permit. Typical permit requirements for spreading and injection projects are summarized in Table 3-3.

Table 3-3. Typical Permit Requirements for Groundwater Recharge Projects

Project Type	Aboveground Treatment	Dilution	Aquifer Retention Time
Spreading	Tertiary filtration and disinfection	Initial RWC ≤ 20% Ultimate RWC ≤ 50%	≥ 6 months
Injection	Full advanced treatment	None required	> 6 months

Groundwater Spreading. For projects spreading tertiary disinfected recycled water, the regulations grant 10-log credit for *Giardia* and for *Cryptosporidium* if the aquifer retention time is at least 6 months. Thus, spreading projects are typically permitted with a combination of moderate degrees of treatment coupled with the provision of significant (6 months or greater) aquifer retention time.

Spreading with disinfected tertiary recycled water is frequently limited by low RWC levels; the baseline permitting approach involves a maximum RWC of 50 percent. In this case, significant diluent water is required to reduce the blended water TOC. This high dilution requirement can limit the size of the recycled water project, particularly if significant diluent water is not available.

Groundwater Injection. Given the requirement for FAT, groundwater injection projects offer significantly more barriers to pathogenic microorganisms. Consequently, FAT projects are less reliant on the aquifer to help meet the pathogen credits. In fact, most facilities that provide a combination of MF, RO, and UV-AOP can meet the 10-log requirement for both *Giardia* and *Cryptosporidium*. The pathogen that tends to drive the aquifer retention time requirement is virus, which does not typically meet the 12-log target through FAT alone. Although most FAT projects do not require 6 months of retention time, they use large basins that provide multiple months to years of travel time to the nearest well. Thus, the baseline permitting approach is characterized by the provision of both a high degree of treatment (FAT) and significant retention times (6+ months).

3.2.4.2 Alternative Approach for High-Capacity Injection Projects

One factor that can limit the capacity of groundwater injection projects, assuming factors such as hydraulic conductivity do not limit flow through the aquifer, is the size of the available aquifers. As the aquifer size decreases, the retention time available for a given flow rate also decreases. Many of the groundwater injection projects in the Los Angeles region have access to large basins that allow them to easily provide long (6+ months) retention times for both groundwater injection and spreading. In other regions of the state, however, projects may be constrained by aquifers whose size may impact the ability to provide the long retention times (Lau et al. 2016). One option for these projects to maximize their capacity is to seek regulatory approval for shorter aquifer retention times.

For a given aquifer size (or volume, *V*), the largest project capacity (or flow, *Q*) can be achieved by minimizing the retention time in the ground (*t*). If retention time is calculated as $t = V/Q$, then project capacity (*Q*) can be optimized according to the equation $Q = V/t$. By setting *t* to its minimum value (2 months), *Q* is maximized. While the regulations allow retention time as low as 2 months, DDW has stated that projects should not assume that they will easily be permitted to operate under these conditions. Box 1 (see page 21) describes the steps taken by the first injection project to receive conceptual approval for a 2-month retention time. The intent is to demonstrate the level of effort needed to pursue a more challenging permitting approach.

The general configuration of public health protections provided by the GWR regulations is illustrated in Figure 3-5 a. In general, PR systems protect public health by balancing a combination of treatment, monitoring, and retention time. If the retention time component becomes shortened, this three-legged stool becomes unbalanced, and may threaten public health. One approach is to compensate for shorter retention time by augmenting both the treatment and monitoring provided (Figure 3-5 b).

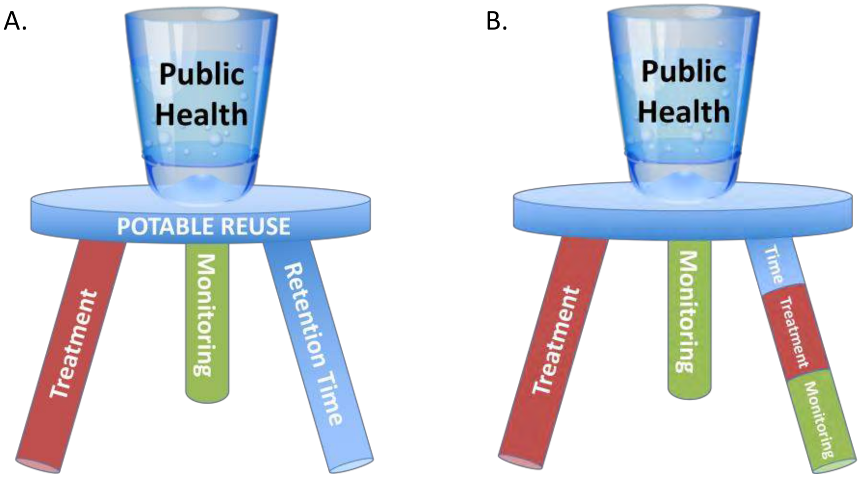


Figure 3-5. Public health protections provided by groundwater recharge projects with (a) baseline permitting approaches, and (b) alternative permitting approaches

The example below of the Padre Dam Municipal Water District (Padre Dam) is of relevance to Valley Water for multiple reasons, including the recent work undertaken by the City of San José to obtain DDW approval for free chlorine disinfection of its recycled water. Based on the Padre Dam experience, there is a template for permitting short retention time projects that relies on enhanced treatment and monitoring. One option for increasing the pathogen control of the standard FAT process (particularly to achieve needed virus credits) is free chlorine disinfection. While the City of San José did not have PR as an explicit driver for its study, the credit that DDW is anticipated to give its NPR system will be applicable for crediting a PR facility. Leveraging this work may offer a cost-effective way to open the door to alternative permitting approaches if needed.

Box 1
Padre Dam Municipal Water District High-Capacity Injection Project

Padre Dam is the first groundwater injection project to receive conceptual approval from DDW to operate at the 2-month retention time (DDW 2017a). The first step in this permitting approach was to identify additional pathogen credits that could be leveraged. One option was to add an additional treatment process, though this approach entails both higher capital and operational expenses. Padre Dam's approach was to seek regulatory approval to receive additional credits for the chlorine disinfection process at its water recycling facility. Furthermore, Padre Dam offered to enhance the monitoring of its system; by increasing the frequency of monitoring for some key parameters, Padre Dam became less dependent on the aquifer for *time* to detect and respond to issues. The general approach was developed and presented to both a National Water Research Institute (NWRI)-led IAP and DDW. With the consent of the IAP and DDW, Padre Dam's project team developed a testing plan for a year-long demonstration study. The goal of that study was to develop the data needed to permit and design the future full-scale GWR system.

Based on feedback from the IAP and DDW and per the testing plan, a 0.1-mgd demonstration facility was designed and constructed (Figure 3-6). One of the key goals of the project was to demonstrate the effectiveness of a free chlorine disinfection approach to achieve higher virus reduction credits. This entailed designing and testing a free chlorine control system using multiple rounds of virus challenge testing. As a result of this effort, DDW gained confidence that a well-designed and operated system could achieve significant virus inactivation (5+ log of inactivation) and that a control system could be used to continuously maintain that pathogen barrier. Based on this study, DDW granted conceptual approval for the free chlorine approach that is integrated into the full-scale design. The results of the free chlorine study and the other elements of the test plan were presented to the IAP and DDW at the end of the year-long testing period. Based on the findings, the IAP endorsed the project and determined that the approach justified a reduction of the response retention time to the 2-month minimum. On March 24, 2017, DDW gave conceptual approval for Padre Dam's GWR project with the minimum 2-month retention time—the first project to receive such approval.

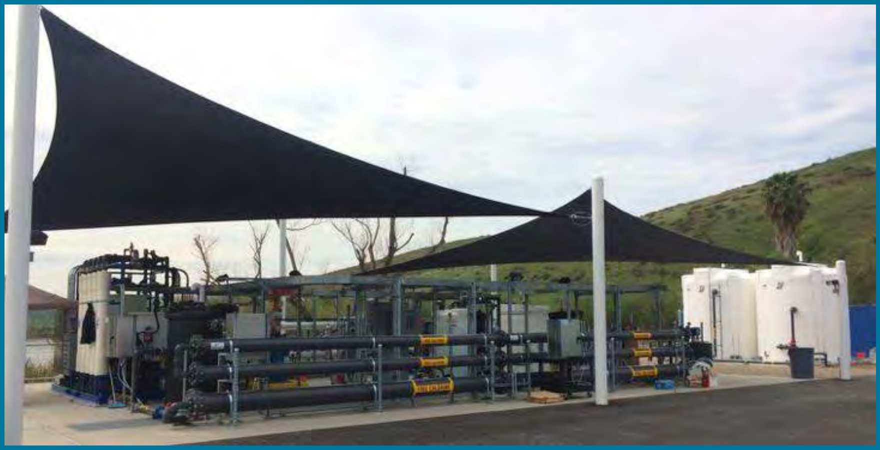


Figure 3-6. Padre Dam 0.1-mgd demonstration facility

3.2.4.3 Alternative Approach for High-Capacity Spreading Projects: Case Study 2

As discussed in Section 3.2.2, one of the major factors limiting the capacity of spreading projects is the requirement to reduce (through dilution) the concentration of recycled water TOC to the 0.5 mg/L level. Based on the RWC calculation, a well-treated tertiary disinfected recycled water with 5 mg/L of TOC would need to be diluted 10-to-1 with diluent water (10 percent recycled water, 90 percent diluent water). One way to increase project capacity, therefore, would be to develop strategies to further reduce the TOC of the recycled water. Box 2 describes the work being done by the Los Angeles Bureau of Sanitation (LASAN) to increase the capacity of its spreading basins.

Box 2
Los Angeles Bureau of Sanitation High-Capacity Spreading Project

LASAN is pursuing a strategy to increase the capacity of its spreading basins. LASAN's approach is to optimize the biodegradability of the recycled water (through ozone treatment), drive down the TOC through biodegradation (both with biological activated carbon [BAC] and SAT), and thereby increase the RWC. LASAN designed and constructed a demonstration facility that uses ozone (in lieu of chlorine) to satisfy the pathogen reduction requirements of Title 22 (Figure 3-7). An added benefit of ozone over chlorine is that it is capable of rendering organic material (i.e., TOC) more amenable to biological degradation. In essence, the ozone cleaves larger, more refractory organics into smaller constituents that are more easily consumed by microbiological populations.

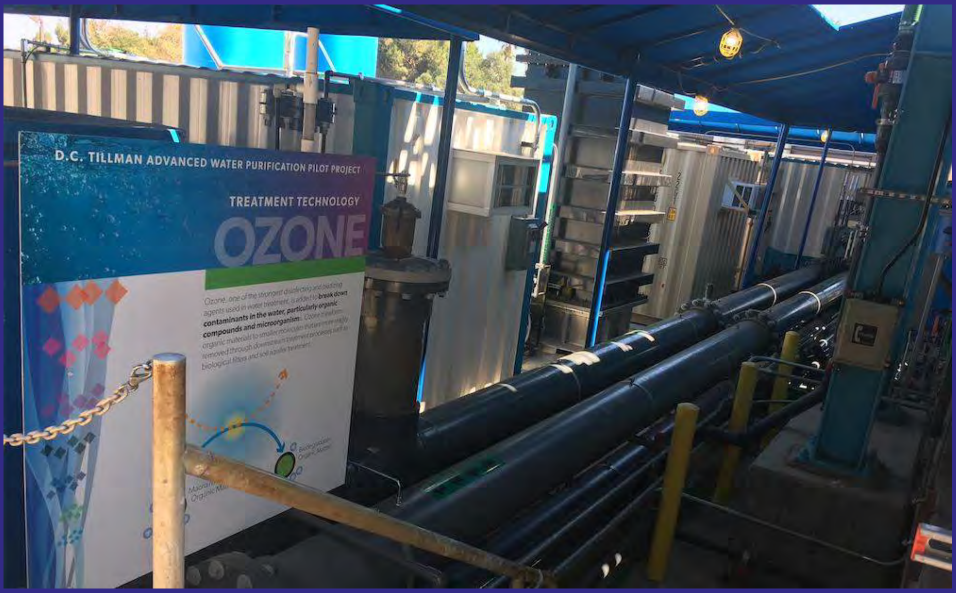


Figure 3-7. Ozone treatment system at the Donald C. Tillman Advanced Water Purification Pilot project

The GWR spreading regulations set limits on the initial RWC that projects must meet, but offer pathways for alternative, higher RWCs if equal levels of public health protection can be demonstrated. This approach has been studied in past research projects and is of interest for multiple agencies in Southern California, including the Upper San Gabriel Valley Municipal Water District. Such an approach offers ways to maximize project capacity while using a lower-cost, non-RO-based treatment train.

3.3 Surface Water Augmentation Regulatory Requirements

This section describes SWA regulatory requirements, including a regulatory summary, public health criteria, environmental criteria, and permitting approaches.

3.3.1 Regulatory Summary

SWA refers to the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply. Final SWA regulations were released in 2018 with an effective date of October 1, 2018. The following discussion provides an overview of the provisions most relevant to agencies considering implementing an SWA project.

3.3.2 Public Health Criteria

Many of the requirements for SWA projects are similar to those required under the GWR regulations. Key provisions of the SWA regulation include pathogenic microorganism control, chemical control, treatment and monitoring requirements, source control, and reservoir requirements. Reservoir requirements—including dilution and retention time—are discussed first because they impact the degree of treatment required.

3.3.2.1 Dilution Criteria

In SWA, the reservoir itself plays an important role in public health protection. The first benefit of the reservoir is its ability to provide *dilution.* Dilution mitigates contamination by reducing the concentration of compounds present in the recycled water. The dilution and mixing criteria in the SWA regulations require that water withdrawn from the reservoir contains no more than either of the following:

- 1 percent, by volume, of recycled municipal wastewater that was delivered to the reservoir during any 24-hour period
- 10 percent, by volume, of recycled municipal wastewater having been subjected to additional treatment producing no less than an additional 1-log reduction of enteric virus, *Giardia* cysts, and *Cryptosporidium* oocysts

A scenario wherein 1 percent of the withdrawn water is composed of recycled wastewater corresponds to a 100:1 dilution of the recycled water in the reservoir. Similarly, a withdrawal composed of 10 percent recycled water corresponds to 10:1 dilution in the reservoir.

The minimum level of dilution (100:1 or 10:1) must be provided under all conditions. Hydrodynamic modeling is required to identify the worst-case combination of a variety of conditions (e.g., stratification, wind speed and direction, temperature) and ensure that under these conditions, the dilution requirement is still met. Tracer studies are also required to further calibrate and improve the modeling, both prior to and within 6 months of augmentation (see Figure 3-8). The regulations specify that an IAP assist DDW by reviewing and approving the results of this modeling. No pathogen log removal credits are given for time spent or dilution achieved in the reservoir.

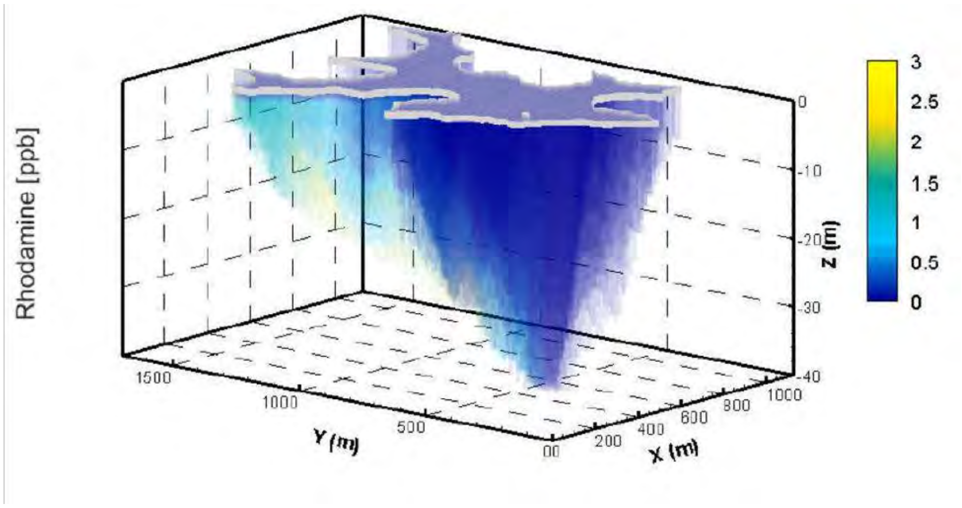


Figure 3-8. Example of a hydrodynamic model replicating a tracer study

Source: Flow Science, 2018.

3.3.2.2 Theoretical Retention Time Criteria

In addition to providing dilution, SWA reservoirs must provide a minimum theoretical retention time, defined as the total volume in the reservoir at the end of a month (V) divided by the total flow out of the reservoir during that month (Q). Per the regulations, the initial theoretical retention time (V/Q) of all projects must be no less than 180 days (6 months). The regulations do allow for alternative theoretical retention times: projects can request alternatives as low as 120 days (4 months) without additional treatment requirements, and as low as 60 days (2 months) with the provision of additional treatment. Projects providing less than a 60-day V/Q would not meet the SWA regulations and would, therefore, be considered DPR projects.

3.3.2.3 Treatment Requirements

The treatment criteria specify requirements for the baseline degree of treatment that must be provided at the AWTF. In brief, SWA requires FAT consisting of RO and AOP with specific requirements for treatment performance and surrogate monitoring.

3.3.2.4 Pathogenic Microorganism Control

Pathogen log reduction requirements are dependent on both the dilution and theoretical retention time achieved in the reservoir (discussed above). The SWA regulations allow pathogen credits to be achieved at both the WWTP and AWTF prior to the reservoir, as well as through subsequent treatment at the drinking water treatment facility (DWTF). The regulations require post-reservoir treatment at a DWTF in compliance with the Surface Water Treatment Rules, i.e., one that achieves a minimum 4/3/2 log reduction of virus, *Giardia,* and *Cryptosporidium*, respectively. The remaining credits must be achieved at the WWTP and AWTF, with the regulations specifying two levels of treatment based on the degree of dilution provided by the reservoir:

1. For projects achieving a minimum 100-fold dilution of the recycled water, the total amount of treatment required is 12/10/10 for virus, *Giardia,* and *Cryptosporidium (V/G/C)*. This translates to a minimum of 8/7/8 being achieved through the WWTP and AWTF (assuming the DWTF will provide 4/3/2). Treatment must be provided by at least two separate treatment processes, each achieving at least 1-log reduction, with no more than 6-log credit for any process.

2. For projects achieving a minimum 10-fold dilution of the recycled water, an additional 1-log pathogen reduction through treatment is required prior to the reservoir. In other words, the WWTP and AWTF must provide a minimum of 9/8/9 for an overall total log removal requirement of 13/11/11. Treatment must be provided by at least three separate treatment processes, each achieving at least 1-log reduction, with no more than 6-log credit for any process.

In addition to dilution, the project's theoretical retention time also impacts the degree of treatment required. Additional treatment is required whenever a project proposes a minimum theoretical retention time of less than 120 days. The regulations require "no less than one $\log_{10}$ reduction" beyond what would otherwise be required based on the treatment and dilution provided. Table 3-4 summarizes the treatment requirements for SWA projects depending on the dilution and theoretical retention time in the reservoir.

Table 3-4. Summary of Treatment, Dilution, and Theoretical Retention Time Criteria for SWA

Dilution	V/Q (days)	Log Removal Credit (V/G/C)		Number of Treatment Processes	Additional Considerations
		WWTP/AWTF	Total		
100:1	≥180	8/7/8	12/10/10	2	--
	<180–120	8/7/8	12/10/10		State Board approval
	<120–60	≥9/8/9	≥13/11/11		State Board approval
10:1	≥180	9/8/9	13/11/11	3	--
	<180–120	9/8/9	13/11/11		State Board approval
	<120–60	≥10/9/10	≥14/12/12		State Board approval

Augmentation must be suspended if the log reduction of any of the regulated pathogens drops more than two logs below the required levels for more than 4 consecutive hours, or for a total of 8 hours in a week. Written approval from the State and Regional Boards is required to reinstate production after a suspension.

3.3.2.5 Source Control Requirements

The source control requirements for SWA are the same as those for GWR projects. The wastewater management agency participating in the SWA project must maintain an industrial pretreatment program and a source control program that includes the following:

- An assessment of the fate of State and Regional Board-specified contaminants through both the wastewater and recycled wastewater treatment systems
- Source investigations and monitoring focused on State- and Regional Board-specified contaminants
- An outreach program to industrial, commercial, and residential communities in areas that supply the SWA project with wastewater for managing and minimizing contaminants at the source
- A current inventory of all contaminants assessed in this program, including any new contaminants that result from the introduction of new sources or changes to existing sources

The regulations for source control for SWA projects are more detailed and complex than those for pretreatment under NPDES permits. They are differentiated primarily by the focus on providing a barrier for the protection of human health, rather than focusing on the quality of wastewater discharged (i.e., environmental health). Additionally, source control programs give wastewater agencies the authority to regulate residential discharges, which is not afforded under pretreatment programs. Each wastewater agency that would be a source of recycled water to the SWA project would need to consider the feasibility and expense of implementing a source control program.

3.3.2.6 Alternatives

Chapter 3 of the SWA regulations includes an “alternatives clause” (Section 60320.330) that allows project sponsors to apply for alternatives to any of the requirements in Chapter 3. Alternatives require written consent from the State Board and must demonstrate that they provide an equal or better degree of public health protection. While broad in concept, it is unlikely that certain requirements will have much flexibility—e.g., the use of RO in the treatment train—though this clause could have implications for other project aspects. An IAP must be convened to approve alternative projects and there may be a need to conduct a public hearing to disseminate information if requested by the State Board.

The broad clause in Chapter 3 does not extend to Chapter 17. The only section in Chapter 17 that allows for flexibility is the allowance for “alternative” theoretical retention times (refer to Section 3.3.2.2). The approval of an IAP may be required for alternative theoretical retention times.

3.3.2.7 Other

Beyond the aforementioned topics, the regulations specify requirements for a number of additional elements. A summary of the requirements in each article of the relevant regulations is shown in Table 3-5.

Table 3-5. Chapter 3. Article 5.3. Indirect Potable Reuse: Surface Water Augmentation

Section	Title	Description
60320.301	General Requirements	Includes development of a joint plan between water recycling agency and public water system; demonstration of “technical, managerial, and financial” capability; compliance
60320.302	Advanced Treatment Criteria	Requirements for FAT, process monitoring, demonstration testing, reporting
60320.304	Lab Analyses	Laboratory requirements for analysis of chemicals, both with and without MCLs
60320.306	Wastewater Source Control	Requirements for source control program
60320.308	Pathogenic Microorganism Control	Requirements for virus, *Giardia*, and *Cryptosporidium* removal through the advanced treatment process; options for alternative levels of treatment; responses to failures
60320.312	Regulated Contaminants and Physical Characteristics Control	Requirements for monitoring of various groups of regulated chemical contaminants; response to exceedances; monitoring
60320.320	Additional Chemical and Contaminant Monitoring	Requirements for additional chemical testing and reporting, including NLs and other contaminants of concern
60320.322	SWSAP Operation Plan	Identifies plan requirements including operations, maintenance, analytical methods, monitoring, reporting, and ongoing training
60320.326	Augmented Reservoir Monitoring	Monitoring requirements at the reservoir, including sampling locations and frequency
60320.328	Reporting	Includes results of monitoring, operations summary, responses to failure events
60320.330	Alternatives	Permits use of alternatives that provide equivalent or better protection of public health; requirements for approval of alternatives
Chapter 17. Article 9. Indirect Potable Reuse: Surface Water Augmentation		
Section	Title	Description
64668.10	General Requirements and Definitions	Includes definitions, permit requirements, and other elements related to Article 5.3, Chapter 3; requirements for reservoir
64668.20	Public Hearings	Requirements for public interaction, including meetings, Web-accessible information, and customer notifications
64668.30	SWSAP Augmented Reservoir Requirements	Requirements for reservoir as approved surface water supply; retention time requirements; tracer study and modeling requirements; dilution requirements

3.3.3 Environmental Criteria

This section describes environmental criteria for SWA.

3.3.3.1 Basin Plan Criteria

The reservoirs of Santa Clara County encompass several beneficial uses, as defined in the SFB Basin Plan:

- Municipal and domestic supply (MUN)
- Agricultural supply (AGR)
- Groundwater recharge (GWR)
- Commercial and sport fishing (COMM)
- Cold freshwater habitat (COLD)
- Fish migration (MIGR)
- Fish spawning (SPWN)
- Warm freshwater habitat (WARM)
- Wildlife habitat (WILD)
- Water contact recreation (REC-1)
- Non-contact water recreation (REC-2)

The SFB Basin Plan contains both narrative objectives and numerical water quality objectives. The combination of these objectives defines the level of water quality that must be maintained within the region. If water quality in a reservoir is better than that prescribed by the SFB Basin Plan, the state Antidegradation Policy (described below) applies.

Narrative Water Quality Objectives

The SFB Basin Plan contains narrative water quality objectives for the following parameters: bioaccumulation, biostimulatory substances, color, floating materials, oil and grease, population and community ecology, radioactivity, salinity, sediment, settleable material, suspended material, sulfide, tastes and odors, toxicity, and turbidity. In general, the narrative water quality objectives specify that constituents not be present at levels that cause nuisance or adversely affect beneficial uses.

Numerical Water Quality Objectives

The SFB Basin Plan specifies numerical water quality objectives for several constituents. Bacteriological standards are summarized in Table 3-6 for recreational and municipal water uses. Additional objectives are summarized below.

Table 3-6. Water Quality Control Plan for the SFB Basin Bacterial Criteria for Relevant Beneficial Uses

Beneficial Use	Fecal Coliform (MPN/100 mL)	Total Coliform (MPN/100 mL)
Water contact recreation (REC-1)	Geometric mean < 200 90th percentile < 400	Median < 240 No sample > 10,000
Non-contact water recreation (REC-2)	Mean < 2,000 90th percentile < 4,000	--
Municipal supply (MUN)	Geometric mean < 20	Geometric mean < 100

Dissolved oxygen:

- Cold water habitat: 7.0 mg/L minimum
- Warm water habitat: 5.0 mg/L minimum
- pH: must remain between 6.0 and 8.5. Controllable water quality factors shall not cause changes greater than 0.5 unit in ambient pH levels.
- Temperature: The temperature of any cold or warm freshwater habitat shall not be increased by more than 5 degrees Fahrenheit (°F) (2.8 degrees Celsius [°C]) above natural receiving water temperature. Cold freshwater habitats support trout and may support anadromous salmon and steelhead. They are often well-oxygenated and fed by soft waters, making fish more susceptible to toxic metals. Warm freshwater habitats support bass, bluegill, perch, and non-fish species, such as frogs, crayfish, and insects. Warm freshwater habitats are generally lakes and reservoirs, though some minor streams may serve this purpose.
- Un-ionized ammonia:
  - Annual median < 0.025 mg/L
  - Maximum, Central Bay = 0.16 mg/L
  - Maximum, Lower Bay = 0.4 mg/L
- MCLs: To protect the MUN beneficial use designation, SFB Basin Plan water quality objectives for regulated chemicals are established at the corresponding drinking water MCLs and sMCLs as described in Section 3.2.3.1. It is noteworthy that, while the MCLs established in the CCR apply to the final treated potable supply delivered to potable water customers, the SFB Basin Plan applies these MCLs directly to the raw (untreated) water stored in surface water reservoirs used for municipal supply.

3.3.3.2 California Toxics Rule

The U.S. Environmental Protection Agency (EPA) promulgated the *California Toxics Rule* (CTR) in 2000 (EPA 2000). The CTR establishes water quality standards for toxic constituents for inland surface waters of California.[1] CTR standards apply to regulated surface waters with public water supply and aquatic life beneficial use designations. Applicable CTR receiving water standards include:

- Short-term (1-hour) criterion maximum concentration (CMC) standards for the protection of freshwater habitat from acute effects
- Longer-term (4-day) criterion continuous concentration (CCC) standards for the protection of freshwater habitat from chronic effects
- Longer-term (chronic) public health standards for the consumption of water and organisms

CTR receiving water standards for the protection of aquatic habitat include standards for dissolved metals, cyanide, pentachlorophenol, polychlorinated biphenyls (PCB), and chlorinated pesticides. CTR standards for the protection of human health (consumption of water plus organisms) include standards for dissolved metals, cyanide, asbestos, dioxins and furans, volatile organic compounds, acid-extractable compounds, base neutral compounds, PCBs, chlorinated pesticides, and DBPs.

The State Board in 2000 adopted the State Implementation Policy (SIP) to provide standardized guidance to Regional Boards for regulating discharges of toxic substances to receiving waters.[2] The SIP establishes protocols under which Regional Boards can consider and designate receiving water mixing zones and dilution credits in establishing NPDES effluent limits that implement the CTR receiving water standards.

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[1] CTR standards are established within Title 40, Section 131.38 (40 CFR 131.38) of the *Code of Federal Regulations*.

[2] Procedures for CTR implementation are established by the State Board in *Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP) (State Board 2000).

3.3.3.3 Thermal Plan Requirements

The State of California Water Quality Control Plan for the Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan) was adopted by the State Board in 1971, and revised in 1972, and again in 1975.[3] The Thermal Plan establishes statewide standards governing allowable temperature in discharges to state waters. Key temperature control provisions for discharges to inland surface waters include:

- Thermal waste discharges having a maximum temperature greater than 2.8°C above the natural receiving water temperature are prohibited
- Elevated temperature wastes shall not cause the temperature of warm interstate waters to increase by more than 2.8°C above natural temperature at any time or place[4]

Limitations on temperature increases will be a consideration for SWA projects because the higher temperature of wastewater will result in a higher temperature advanced treated discharge.

3.3.3.4 Chlorine Residual Requirements

EPA has established national criteria[5] for chlorine residual concentrations to protect freshwater aquatic life, including:

- CMC (1-hour) value of 19 micrograms per liter (µg/L)
- CCC (4-day) value of 11 µg/L

Draft statewide chlorine standards currently being considered by the State Board would require that dischargers reduce chlorine residual in discharges to receiving waters to as close to zero as practicable.[6] Pending approval of statewide standards for chlorine residual, the State Board (2014) has implemented the EPA chlorine residual criteria in the current statewide NPDES permit governing discharges to surface waters from drinking water systems.[7] Because the criteria are lower than the sensitivity of many chlorine analyzers, non-detect values from a chlorine meter are typically sufficient to satisfy the chlorine residual requirements. If free chlorine disinfection is used as part of an SWA project, provisions will need to be provided for dechlorination prior to discharge to a reservoir.

3.3.3.5 Antidegradation Criteria

The State of California policy on antidegradation is set forth in State Board Resolution 68-16,[8] which establishes the following policy that requires maintenance of high-quality waters:

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[3] The 1975 version of the Thermal Plan was implemented through adoption of State Board Resolution 75-89.

[4] A temperature of 2.8°C corresponds to 5°F.

[5] U.S. Environmental Protection Agency (EPA). National Recommended Water Quality Criteria. Located online at the EPA website at: water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. Updated 2014.

[6] State Water Resources Control Board (State Board). *Total Residual Chlorine and Chlorine-Produced Oxidants Policy of California*. 2006.

[7] State Water Resources Control Board (State Board). *Order WQ 2014-0194-DWQ, General Order CAG140001, Statewide National Pollutant Discharge Elimination System (NPDES) Permit for Drinking Water System Discharges to Waters of the United States*. 2014.

[8] Resolution 68-16, *Statement of Policy with Respect to Maintaining High Quality Waters in California* was adopted by the State Board on October 28, 1968. California's 1968 antidegradation policy predates the creation of the U.S. Environmental Protection Agency, the 1972 federal Clean Water Act, and the implementation of the federal NPDES permit program.

> *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water and will not result in water quality less than that prescribed in the policies.*

The State of California antidegradation policy (which preceded the 1972 Clean Water Act and federal antidegradation regulations) applies to all state waters, and requires that the existing water quality be maintained unless it is demonstrated that the benefits associated with the proposed water quality degradation outweigh the detriments. Any proposed SWA project will require an evaluation of the baseline water quality of the receiving reservoir and the potential for degradation due to SWA.

3.3.4 Permitting Baseline Approach

As with GWR, the most straightforward permitting approach is to offer the broadest balance of the public health elements that are contained within the regulation. In SWA, the main public health components include treatment and monitoring, dilution, and theoretical retention time. Projects can offset higher treatment and monitoring requirements by providing higher levels of dilution and theoretical retention time. The “baseline” approach would be to pursue a project that provided (1) 6 or more months of theoretical retention time, (2) minimum dilutions in excess of 100-to-1, and (3) treatment meeting the 8/7/8 pathogen log reductions for V/G/C. Under such conditions, no conditions would trigger additional regulatory hurdles (as would happen for retention times less than 4 months) or would require higher degrees of treatment (as would be needed for dilutions less than 100:1).

Given that San Diego’s SWA project is the only one currently permitted in California, the steps required to permit an SWA project—even under a baseline strategy—may be more involved than a GWR project, where the industry and regulators have more than 50 years of experience. Thus far, both projects pursuing SWA—the City of San Diego and the East County Advanced Water Purification program—have a number of commonalities that have contributed to their progress:

- Demonstration facilities used to develop water quality and performance data in accordance with DDW-approved test plans
- Engagement with IAPs and DDW
- Reservoir and hydrological modeling studies
- Tracer studies

All of these findings have been presented to regulatory bodies and have been critical in both their permitting efforts (e.g., Engineering Reports) and the design of the full-scale facilities. It is likely that projects that are pursued in the near future will also need similar levels of effort to support their permitting efforts.

Because only one SWA project has completed the permitting and design phase, there are much fewer precedents for the “baseline” SWA permitting approach compared to GWR. The City of San Diego’s project and the East County Advanced Water Purification program are both pursuing more aggressive projects, i.e., ones that trigger one or more clauses in the regulations that make these permitting approaches more involved. Box 3 describes the City of San Diego’s experience permitting an SWA project that provides the minimum levels of dilution (10-to-1) and theoretical retention time (2 months).

Box 3
Alternative Permitting for Surface Water Augmentation in San Diego

San Diego's original concept for its SWA project was to augment the San Vicente Reservoir, a 247,000-acre-foot reservoir that would provide years of theoretical retention time for a 30-mgd project. Nevertheless, the reservoir is located approximately 25 miles northeast from the city of San Diego in a mountainous region in the eastern part of the county. While offering advantages in terms of both long theoretical retention times and high degrees of dilution, it would also incur expensive pipeline infrastructure traversing multiple jurisdictions. At the time the project was conceived, there were no draft SWA regulations. Over the course of the project, however, the California State Expert Panel began to provide input to DDW and the State Board about the shape of the future SWA regulations. As it became clearer that the regulations might allow for broader flexibility in reservoir operation, San Diego began to evaluate alternative options.

The alternative that it ultimately selected was the augmentation of Lake Miramar, a 6,000-acre-foot reservoir adjacent to the Miramar Water Treatment Plant, approximately 7 miles from the proposed advanced treatment facility at the North City Water Reclamation Plant. This option would (1) reduce the pipeline costs by more than 50 percent, (2) allow for faster project completion, (3) decrease complexity by involving only a single agency, and (4) lead to lower environmental impacts. The City concluded that these benefits outweighed the "costs" of pursuing a project with a less-certain permitting pathway. Based on the proposed project size (30 mgd) and the size of the reservoir, the project would be able to provide only 2 months of theoretical retention time at buildout. At the time of the project's conception, this short retention time option was not yet available in the regulation. For this reason, the City invested in efforts to demonstrate that the Miramar SWA project could be equally protective of public health.

The City determined that reducing certain protections—e.g., dilution and retention time—would require compensation by other elements. Accordingly, its 1-mgd demonstration FAT facility (Figure 3-9) was augmented to provide additional treatment barriers (ozone and biological activated carbon) to further guarantee the consistency of the high-quality water used to augment the reservoir. San Diego discussed this option with its IAP, presented the findings from its year-long study on the high performance of the system, and—based on these findings—received IAP support for an SWA project with a 2-month retention time. Through these interactions, DDW also provided input that helped the project team develop the data necessary to approve this approach. San Diego gained final approval for the State's first SWA permit in May 2020.

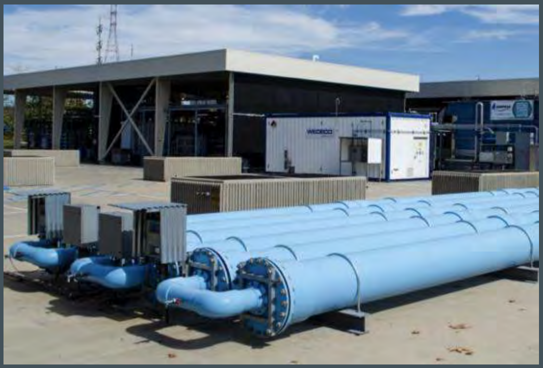


Figure 3-9. Demonstration pure water facility at San Diego's North City Water Reclamation Plant

3.4 Direct Potable Reuse

This section describes DPR, including a regulatory summary and key considerations.

3.4.1 Regulatory Summary

In 2010, SB 918 required CDPH, now DDW, to investigate the feasibility of developing uniform water recycling criteria for DPR and to report its findings to the State Legislature by December 2016. In addition, SB 918 mandated that an expert panel be convened to advise DDW on scientific and technical matters regarding DPR feasibility. The expert panel released its final report in August 2016, concluding that it is feasible to develop uniform criteria for DPR. The panel suggested six research topics that should be investigated to further ensure the protectiveness of DPR, which are summarized in Figure 3-10.

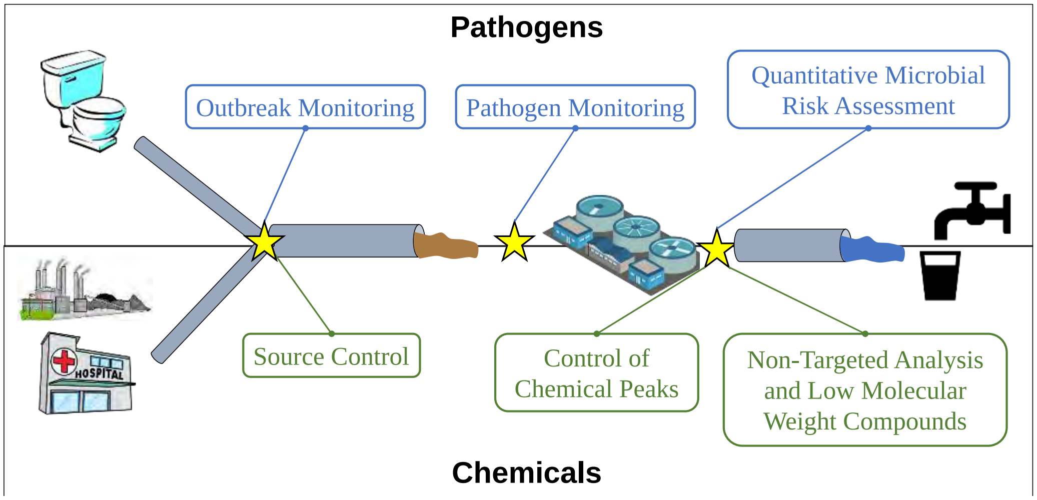
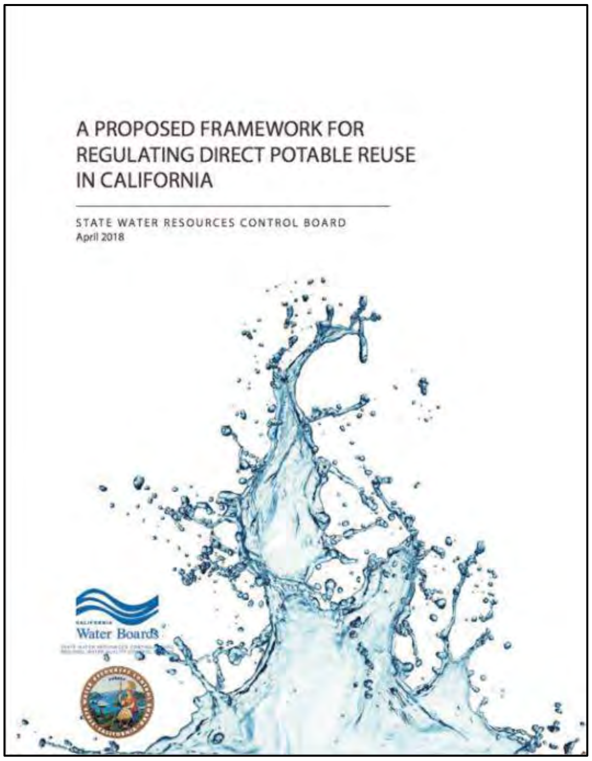

Pathogens
Outbreak Monitoring
Pathogen Monitoring
Quantitative Microbial Risk Assessment
HOSPITAL
Source Control
Control of Chemical Peaks
Non-Targeted Analysis and Low Molecular Weight Compounds
Chemicals

Figure 3-10. Six DPR research topics identified by the State expert panel

DDW delivered its final report to the State Legislature in December 2016, concluding that the six research topics must be addressed *before* uniform water recycling criteria can be developed.

Assembly Bill (AB) 574, which was signed into law in October 2017, requires that the State Board develop uniform water recycling criteria for RWA by 2023. It also mandated the development of a framework for the regulation of PR projects by June 2018; the draft framework was released by DDW on April 19, 2018 (Figure 3-11). It should be noted that AB 574 specifies that the State Board retains the right to permit PR projects pursuant to the Health and Safety Code before the adoption of uniform water recycling criteria. Although the State Board has the authority, it is not clear what requirements would be imposed for a DPR project seeking permitting prior to the development of uniform DPR regulations.



A PROPOSED FRAMEWORK FOR REGULATING DIRECT POTABLE REUSE IN CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD
April 2018

Figure 3-11. Framework for regulating DPR in California, released by the State Board's DDW in April 2018

3.4.2 Key Considerations

Permitting a DPR project at this early stage of the regulatory development process will be challenging. First and foremost, the regulators are waiting for the results of multiple parallel research efforts that are currently under way. In its report to the State Legislature, DDW stated that these knowledge gaps would need to be addressed before it could develop uniform criteria (State Board 2016). Furthermore, DDW understands the benefit of *experience* on the development of its previous regulations: GWR regulations evolved multiple times over the nearly 40-year period during which they were in draft form, with each iteration improving on the public health protections provided. While the SWA regulations were written without the benefit of an existing project, the regulators drew from the GWR experience to develop the SWA regulations. As the transition is made now from SWA to DPR, the regulators will leverage PR experience and research broadly, including outside of California, to help inform DPR regulations. Accordingly, DDW will likely prefer a cautious and deliberate approach to permit DPR projects before the regulations are developed.

While the exact requirements for DPR systems are not yet fleshed out, numerous documents provide indications of the elements that will be included. In its DPR Regulatory Framework document, DDW stated that “DPR regulations will need to include additional criteria to compensate for the loss of the protective benefits assured by the presence of a meaningful environmental buffer in IPR projects” (State Board 2018). Echoing this, the State expert panel suggested that the benefits of the environmental buffer could be substituted with enhanced reliability provided by mechanical systems and treatment performance (Olivieri et al. 2016). These include the following:

- Enhanced treatment
- Control of chemical contaminants

- Monitoring and control
- Source control
- Operator certification
- TMF capabilities

3.4.2.1 Enhanced Treatment

Both the State expert panel and the recent DPR Regulatory Framework document have indicated that DPR will require additional treatment beyond what has been specified for IPR scenarios (Olivieri et al. 2016; State Board 2018). While they have not provided specific requirements for the particular treatment train or trains needed, they have indicated that it will be an enhanced form of the FAT process. What enhancements are necessary have not been determined, though DDW offered that O3/BAC pretreatment may be an option (State Board 2018).

The rationale for the enhanced treatment is that it can help compensate for the lack of an environmental buffer. By requiring treatment redundancy, i.e., treatment beyond the minimum needed for public health protection, the system will reduce its probability of failing to meet the minimum targets. The consistency with which the train will be required to meet the risk-based health targets will likely increase. Requiring redundant treatment is a practical way of ensuring that the log removal value (LRV) targets are consistently met. Higher degrees of treatment will also need to be coupled with stricter O&M procedures and tighter control of the treatment barriers (i.e., critical control points) (State Board 2018).

Currently, the State Board is sponsoring three research projects that will impact the level of treatment ultimately required for DPR: one to look at performance evaluations and quantitative microbiological risk assessment (QMRA), one to evaluate the concentration of pathogens that might be present in the raw sewage source water, and a study to understand how disease outbreaks might impact those numbers. The findings from these studies will help to inform the future minimum criteria for enhanced DPR treatment.

3.4.2.2 Control of Chemicals

The general framework for controlling chemicals in PR follows three steps: (1) identify chemicals of concern, (2) set up treatment and monitoring to evaluate a suite of relevant chemicals, and (3) specify performance criteria to reduce these chemicals below levels of health concern. This approach is further supported by source control, which aims to limit the discharge of these compounds into the wastewater. In IPR settings, the environmental buffer provides *time* to take samples and evaluate results prior to distributing the water; in DPR this will not be an option. Consequently, the regulatory structure will need to adapt to focus more on the use of surrogates/indicators that can be measured on a continuous basis, in tandem with additional treatment that improves the reliability and robustness of the treatment train (Figure 3-12).

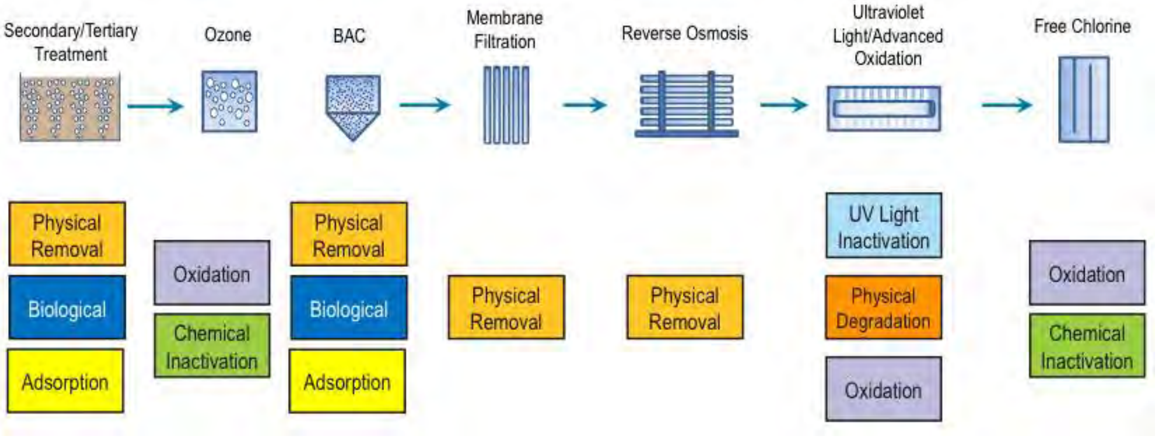


Figure 3-12. Diversity of removal mechanisms provides a high degree of control for chemicals and mitigates unknown chemical contaminants

One group of chemical constituents that is of greater importance in DPR settings are those that have been shown to pass through FAT trains—namely, the low molecular weight organic compounds. Several strategies have been proposed to deal with these compounds, including:

- Enhanced source control
- Provision of additional treatment barriers at the AWTF
- High-frequency monitoring of TOC (or other surrogate[s] for organic compounds) in final effluents

Another future requirement may be the optimization of the WWTP (State Board 2018). In line with the expert panel's treatment recommendations, providing a high degree of treatment at the WWTP—including biological nutrient removal with filtration—further ensures a high-quality, stable source water to feed the AWTF. Future DPR requirements may stipulate the degree of wastewater treatment preceding the AWTF for this reason.

The combination of these efforts—source control, enhanced wastewater and advanced treatment, and continuous monitoring—will help prevent, detect, and respond to any peaks of chemicals that may make their way to and through the WWTP.

3.4.2.3 Monitoring and Control

As the time and distance between the treatment process and consumer grows smaller, it becomes increasingly important to continuously track the status of the treatment processes and purified water quality. If treatment fails, urgent action is required and the only way to respond quickly is to provide a high degree of monitoring and control. The stringency of monitoring will be higher than what is currently required for IPR for both pathogens and chemicals (State Board 2018). DDW has also highlighted the future use of advanced chemical detection techniques, including non-targeted analysis and bioassays.

3.4.2.4 Source Control

As noted above, source control programs will likely be more stringent than those used for existing IPR systems. Per the expert panel report, source control is a priority research topic and the State Board has allocated funds for a future IAP to outline the components and scope of the enhanced source control programs. This ongoing research should provide findings in the next 18 to 24 months.

3.4.2.5 Operator Certification

The water industry has understood the important role that operations will have in the future success of DPR systems. Given the high reliance on engineered systems for public health protection, DPR systems will need operators with a high degree of advanced treatment training. Both the California Water Environment Association (CWEA) and the California-Nevada Section of the American Water Works Association (CA-NV AWWA) joined together to develop and jointly administer a voluntary Advanced Water Treatment Operator (AWTO) certification that includes three different grade levels.

3.4.2.6 Technical, Managerial, and Financial Capacity

The IPR regulations have requirements for the TMF capacity of the project sponsors. DDW has stated that the threshold for TMF capacity will increase as the movement is made from IPR to DPR, since the complexity and sophistication of DPR systems is higher. DPR will typically require a greater number and diversity of treatment processes, more stringent monitoring requirements, and critical control points.

3.4.2.7 Phasing

DDW has emphasized that it would like to progress toward TWA—the most direct form of DPR—in a methodical and phased approach (State Board 2018). Phasing from an IPR project (GWR or SWA) into RWA will have numerous benefits. By starting with GWR/SWA, DDW has a chance to evaluate the capacity of an agency to comply with the IPR regulations, which are strict but not as rigorous as the future DPR regulations. This period also puts lower stakes on the engineered aspects of public health protection because these systems will necessarily be complemented by an environmental buffer. Because a higher degree of rigor will be required for DPR (in terms of treatment, monitoring, control, and operations), having an initial period with IPR may provide an easier pathway to permitting. DDW has stated that it wants to “walk before it runs,” meaning that it would like to move progressively from IPR to RWA and then again slowly from RWA to TWA.

Timing will be a key consideration for the permitting of an RWA project. Per AB 574, DDW anticipates developing uniform regulations by the end of 2023, with the possibility of extending this deadline for 1 year. A phased project that begins with IPR and transitions into RWA could anticipate a high degree of regulatory clarity in the 2023 to 2024 time frame. Agencies looking to pursue TWA might anticipate final regulations 5 years after the development of RWA regulations (e.g., 2028 to 2029).

Section 4: Residuals Management

PR projects can produce significant volumes of residuals. The previous sections have discussed environmental criteria for discharge of treated effluent to end uses (e.g., landscape irrigation for NPR) and environmental buffers (e.g., aquifer discharge for groundwater recharge). This section focuses specifically on the management of residual streams generated by reuse treatment and their potential regulatory requirements.

Most PR applications within California use FAT, which includes low-pressure MF followed by RO and UV-AOP. The low-pressure filtration process produces a relatively small residual flow of backwash water, which can either be discharged via sewer or recycled to the WWTP headworks (Section 4.3). Low-pressure membrane and occasional UV-AOP chemical cleaning produce small volumes of cleaning waste chemicals, which are also discussed in Section 4.3. The largest residual volume produced in an RO-based PR system is RO concentrate, disposal of which is discussed in Section 4.2.

4.1 NPDES Permits

A common strategy for residuals management is to discharge these streams through surface water outfalls, either alone or in combination with existing effluent discharges. In this case, these discharges would be addressed through NPDES permits, which are issued by the Regional Board (either Region 2 – SFB or Region 3 – CC). NPDES permits for discharges to surface waters contain specific requirements that limit the pollutants in discharge effluent. Some pollutant limits are load-based (e.g., pounds per month), but most are concentration-based (e.g., mg/L of TDS). This is a critical consideration for residuals, especially RO concentrate, as they are highly concentrated waste streams that may strain existing NPDES concentration limits if added to the existing discharge stream. NPDES permits also require screening tests for chronic toxicity (a detrimental biological effect on the health of an organism population or community), and in some cases, may also limit daily effluent flow (e.g., SCRWA WWTP). These limitations in effluent flow serve as a strategy to mitigate contaminant discharges into a water body that may be close to or exceeding its beneficial use water quality standards.

There are two types of NPDES permits: General and Individual. The General Permit is intended to cover multiple facilities within a specific category. For example, the SFB Regional Board has a Groundwater General Permit for the *Discharge or Reuse of Extracted Brackish Groundwater, Reverse Osmosis Concentrate Resulting from Treated Brackish Groundwater, and Extracted Groundwater from Structural Dewatering Requiring Treatment* (Order R2-2012-0060), which regulates general waste discharge requirements within those conditions. The full list of General NPDES wastewater permits for California can be found on the State Board website.

The Individual Permit is a permit tailored to a specific facility that is issued by a Regional Board for an effective period not to exceed 5 years. It is anticipated that any WWTP that may receive residuals from PR (e.g., San José/Santa Clara RWF or the Sunnyvale WPCP) would have an individual permit. In instances where RO concentrate is being discharged to a surface water, there may also be a need for a separate NPDES permit (discussed further in Section 4.2).

Discharge of residuals from recycled water projects may require either a new NPDES Individual Permit or modification of an existing NPDES permit. Residuals that are being discharged into an existing sewer system (e.g., RO concentrate) may also require an industrial discharge permit from the municipality that manages that sewer system. If residual streams are routed to existing outfalls, a careful review of potential impacts to existing NPDES permits will be needed to identify whether all effluent discharge water quality requirements will still be met with the new project, or if permit modifications and/or further waste stream treatment is needed. Some issues of concern, particularly in RO concentrate, are TDS, nutrients, metals, and toxicity.

4.1.1 Existing NPDES Permits

Four WWTPs in Santa Clara County have existing NPDES permits: San José/Santa Clara RWF, Sunnyvale WPCP, Palo Alto RWQCP, and SCRWA WWTP. If residuals are to be discharged into the sanitary sewer system upstream of these facilities, the potential impacts to these WWTPs must be considered. The existing NPDES permits for each of these facilities are summarized below.

The NPDES permit limits shown below are set to meet a variety of effluent requirements from various state and federal laws, including the Basin Plan and the National Toxics Rule. Change in discharge from any of these WWTPs (e.g., an increase in TDS and metals from RO concentrate) could impact a WWTP’s ability to continue meeting its NPDES permit limits.

4.1.1.1 San José/Santa Clara Regional Wastewater Facility

San José/Santa Clara RWF serves 1.4 million residents in the San José and Santa Clara region. It treats an average of 110 mgd of wastewater, with a capacity of up to 167 mgd, and discharges advanced secondary-treated effluent to the Artesian Slough, which is a tributary to the South SF Bay via Coyote Creek. Its existing NPDES permit is SFB Regional Board Order R2-2014-0034/NPDES Permit CA0037842, and the effluent limits are summarized in Table 4-1.

Table 4-1. Effluent Limits for San José/Santa Clara RWF

Parameter	Unit	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
5-day carbonaceous biochemical oxygen demand ($CBOD_5$) at 20°C	mg/L	10	---	20	---	---
Total suspended solids (TSS)	mg/L	10	---	20	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N	mg/L	3.0	---	8.0	---	---
Copper, total recoverable	µg/L	11	---	19	---	---
Nickel, total recoverable	µg/L	25	---	33	---	---
Cyanide, total	µg/L	5.7	---	13	---	---
Indeno (1,2,3-cd) pyrene	µg/L	0.049	---	0.098	---	---
Dioxin-TEQ	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---

Source: SFB Regional Board NPDES Permit CA0037842 (effective 11/1/2014).

In addition to these numeric limits, the San José/Santa Clara RWF has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Ceriodaphnia dubia* as the test species.

Typically, discharge into shallow waters or dead-end sloughs is prohibited; however, the San José/Santa Clara RWF has an exception. Because the receiving water is shallow and supports biologically sensitive habitats, the plant has no dilution credit for most parameters; however, the plant does have a dilution credit for cyanide (3:1 ratio).

4.1.1.2 Sunnyvale Water Pollution Control Plant

The Sunnyvale WPCP treats an average flow of 11.9 mgd and discharges advanced secondary-treated effluent to the Moffett Channel, which is a tributary to the South SF Bay via the Guadalupe Slough. Effluent limits are set by SFB Regional Board Order R2-2014-0035/NPDES Permit CA0037621 and summarized in Table 4-2.

Table 4-2. Effluent Limitations for Sunnyvale WPCP

Parameter	Unit	Effluent Limitations				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
$CBOD_5$ at 20°C	mg/L	10	---	20	---	---
TSS	mg/L	20	---	30	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N (October–May)	mg/L	18	---	26	---	---
Total ammonia, as N (June–September)	mg/L	2	---	5	---	---
Copper, total recoverable	µg/L	10	---	19	---	---
Nickel, total recoverable	µg/L	24	---	35	---	---
Cyanide, total	µg/L	7.5	---	17	---	---
Dioxin-TEQ (TEQ = toxicity equivalency)	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---
Bis (2-ethylhenxyl) phthalate	µg/L	5.9	---	12	---	---

Source: SFB Regional Board NPDES Permit CA0037621 (effective 11/1/2014).

In addition to these numeric limits, the Sunnyvale WPCP has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Thalassiosira pseudonana* as the test species.

Sunnyvale WPCP also has an exception that allows discharge to shallow water. Because the receiving water is a shallow, tidal slough with limited upstream freshwater flows, the plant has no dilution credit for most parameters; however, the plant does have a dilution credit for cyanide (4:1 ratio).

4.1.1.3 Palo Alto Regional Water Quality Control Plant

The Palo Alto RWQCP treats 20 mgd of wastewater for six communities: Palo Alto, East Palo Alto, Mountain View, Stanford, Los Altos, and Los Altos Hills. Its effluent is regulated by SFB Regional Board Order R2-2014-0024/NPDES Permit CA0037834, which is summarized in Table 4-3. It discharges secondary-treated effluent into two different discharge points (with the same effluent limits described in Table 4-3)—the first is directly into the South SF Bay, and the second is into Matadero Creek.

Table 4-3. Effluent Limitations for Palo Alto RWQCP						
		Effluent Limitations				
Parameter	Unit	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
$CBOD_5$ at 20°C	mg/L	10	---	20	---	---
TSS	mg/L	10	---	20	---	---
Oil and grease	mg/L	5	---	10	---	---
pH	Standard units	---	---	---	6.5	8.5
Total residual chlorine	mg/L	---	---	---	---	0.0
Turbidity	NTU	---	---	---	---	10
Total ammonia, as N	mg/L	2.7	---	9.5	---	---
Copper, total recoverable	µg/L	21	---	36	---	---
Nickel, total recoverable	µg/L	26	---	31	---	---
Cyanide, total	µg/L	6.2	---	14	---	---
Dioxin-TEQ	µg/L	1.4×10^{-8}	---	2.8×10^{-8}	---	---

Source: SFB Regional Board NPDES Permit CA0037834 (effective 8/1/2014).

In addition to these numeric limits, the Palo Alto RWQCP has a narrative limit for chronic toxicity, such that the effluent does not cause or contribute to toxicity in the receiving water, Routine chronic toxicity testing is conducted monthly using *Pimephales promelas* as the test species.

Palo Alto RWQCP also has an exception that allows discharge to shallow water; Palo Alto's water reuse projects and maintenance of Renzel Marsh help to justify this exception. Furthermore, Palo Alto has dilution credits for cyanide (3.25:1 ratio) and copper (3.5:1 ratio) at both discharge points.

4.1.1.4 South County Regional Wastewater Authority Wastewater Treatment Plant

SCRWA is a joint powers authority established to manage wastewater treatment for the cities of Gilroy and Morgan Hill. SCRWA manages the SCRWA WWTP, which is designed to treat up to 8.5 mgd for dry weather secondary treatment standards and 9.0 mgd for tertiary filtered and disinfected standards. Effluent limitations are regulated by Central Coast Regional Water Quality Control Board (CC Regional Board) Order R3-2017-0028/NPDES Permit CA0049964.

SCRWA's NPDES permit describes three discharge locations, with differing effluent limitations for each. Discharge Point 001 is land application of treated secondary effluent to percolation ponds that are adjacent to Llagas Creek, Discharge Point 002 is disinfected tertiary recycled water to the Pajaro River, and Discharge Point 003 is also disinfected tertiary recycled water for reclamation use. The effluent limitations for Discharge Points 001 and 002 are listed below in Table 4-4 and 4-5, respectively. The effluent for Discharge Point 003 (recycled water for reclamation) must meet the water quality requirements for disinfected tertiary recycled water as described in Section 2 (NPR).

Table 4-4. Effluent Limitations for SCRWA's Discharge Point 001					
Parameter	Unit	Effluent Limitations			
		Average Monthly	Average Weekly	Maximum Daily	12-Month Moving Average
5-day biochemical oxygen demand (BOD_5) at 20°C	mg/L	30	45	--	---
TSS	mg/L	30	45	---	---
Nitrate (as N)	mg/L	5	---	10	---
TDS	mg/L	---	---	---	900
Sodium	mg/L	---	---	---	175
Chloride	mg/L	---	---	---	200
Sulfate	mg/L	---	---	---	150
Boron	mg/L	---	---	---	1.0
pH	Standard units	6.5–8.3 at all times			

Source: CC Regional Board NPDES Permit CA0049964 (effective 12/1/2017).

Table 4-5. Effluent Limitations for SCRWA's Discharge Point 002				
Parameter	Unit	Effluent Limitations		
		Average Monthly	Average Weekly	Maximum Daily
Flow	MGD	---	---	9.0
BOD5 at 20°C	mg/L	10	---	20
TSS	mg/L	10	---	20
Nitrate (as N)	mg/L	5	---	10
Un-ionized ammonia (as N)	mg/L	0.025	---	0.050
pH	Standard units	7.0–8.3 at all times		
TDS	mg/L	1,000	---	---
Sodium	mg/L	200	---	---
Chloride	mg/L	250	---	---
Sulfate	mg/L	250	---	---
Boron	mg/L	1.0	---	---
Chlorine, total residual	mg/L	---	---	a
Chlorine, total residual	mg/L	---	---	a
Copper, total recoverable	µg/L	20	---	42
Lead, total recoverable	µg/L	2.1	---	4.2
Chlorodibromomethane	µg/L	0.40	---	0.80
Dichlorobromomethane	µg/L	0.45	---	0.90
Trihalomethanes, total	µg/L	80	---	160

a. Chlorine concentrations shall at no time exceed detection levels as determined by amperometric titration or other equally sensitive method.

Source: NPDES Permit CA0049964 (effective 12/1/2017).

Regulated by the CC Regional Board, SCRWA has different chronic toxicity testing requirements than the other three plants. Routine monitoring is conducted once per year using the water flea, *Ceriodaphnia dubia*, (survival and reproduction test); fathead minnow, *Pimephales promelas* (larval survival and growth test); and green alga, *Selanastrum capricornutum* (growth test), as test species. If chronic toxicity is detected in the effluent, SCRWA must resample immediately and report the results to the Executive Officer, who will determine whether to initiate an enforcement action, require a Toxicity Reduction Evaluation, or implement other measures.

Unlike the SF Bay plants, SCRWA receives no dilution credit.

4.1.2 Basin Plans

Key drivers for NPDES permits are the SFB Basin Plan and CC Basin Plan. Each of the surface water and groundwater bodies within the SFB and CC Basins has beneficial use designations and establishes the water quality attainment strategies, including total maximum daily loads (TMDL) as required by the Clean Water Act. TMDLs addressed by the Basin Plans include diazinon and pesticide-related toxicity, copper, mercury, selenium, various bacteria, various pathogens, PCBs, and sediment. There are also region-wide and area-specific TMDLs, and NPDES permit limits calculated to support compliance with the Basin Plans.

The pertinent water bodies to Santa Clara County include the Artesian Slough (San José/Santa Clara RWF), the Moffett Channel (Sunnyvale WPCP), the South SF Bay and Matadero Creek (Palo Alto RWQCP), and the Pajaro River (SCRWA WWTP). Each of these water bodies has beneficial use designations (Table 4-6), and associated water quality standards.

Table 4-6. Beneficial Uses of Relevant Water Bodies in Santa Clara County

	San José/Santa Clara RWF	Sunnyvale WPCP	Palo Alto RWQCP		SCRWA WWTP
Beneficial Use(s)	Artesian Slough[a]	Moffett Channel[a]	South SF Bay[a]	Matadero Creek[a]	Pajaro River[b]
Agricultural supply (AGR)					✓
Cold freshwater habitat (COLD)				✓	✓
Commercial and sport fishing (COMM)			✓		✓
Contact recreation (REC-1)	✓	✓	✓	✓	✓
Estuarine habitat (EST)	✓	✓	✓		
Fish migration (MIGR)			✓	✓	✓
Fish spawning (SPWN)			✓	✓	✓
Freshwater replenishment (FRSH)					✓
Groundwater recharge (GWR)					✓
Industrial process supply (PROC)					
Industrial service supply (IND)			✓		✓
Municipal and domestic supply (MUN)					✓
Navigation (NAV)			✓		
Non-contact water recreation (REC-2)	✓	✓	✓	✓	✓
Preservation of rare and endangered species (RARE)	✓		✓	✓	
Shellfish harvesting (SHELL)			✓		
Warm freshwater habitat (WARM)				✓	✓
Wildlife habitat (WILD)	✓	✓	✓	✓	✓

a. *Source: SFB Basin Plan, Table 2-1.*
b. *Source: CC Basin Plan, Table 2-1.*

While water quality limits that are set in the Basin Plan may not directly transfer to NPDES permits, effluent requirements are calculated with the intention of meeting water quality goals set in the Basin Plan. Future recycled water projects that may impact existing NPDES permits (as detailed above) must take those impacts into consideration during development of the project. Increases in constituent concentrations through the discharge of residuals or the diversion of water for reclamation may impact the WWTPs' abilities to meet their existing NPDES permit limits.

4.1.3 Waste Discharge Requirements for Nutrients to San Francisco Bay

Nutrients, such as nitrogen and phosphorus, are also regulated through the NPDES program. While there are currently no numerical limits for nutrients (except for ammonia) within each facility-specific NPDES permit, all WWTPs that discharge into the SF Bay are regulated by Order R2-2019-0017/NPDES Permit CA0038873, titled *Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay.* This region-wide permit sets monitoring and reporting requirements, as well as a mandate to evaluate potential nutrient discharge reduction through treatment optimization, sidestream treatment, or WWTP upgrades.

Whether a nutrient limit will be set in future permit revisions, and what it might be if it is, is still unknown. The limit could be either loading- or concentration-based, or both. For WWTPs that are looking to do water reuse, a concentration-based limit may be challenging to meet, as dilution flow is diverted for water reuse, thereby increasing nutrient concentrations. This would be exacerbated if RO concentrate is also part of that effluent flow.

For projects considering RO, management of the RO concentrate is a critical consideration in the conversation around nutrients. Concentrate streams have high concentrations of nutrients that will make meeting future nutrient limits challenging. A solution to managing RO concentrate streams could be to discharge it into a treatment cell, which will reduce nutrient concentrations before discharging through an outfall. Other management strategies to reduce nutrient loading to the SF Bay could be those that discharge the concentrate elsewhere, like injection or evaporation ponds. The future of effluent limits for nutrients is still unknown, but must be taken into consideration with the development of any new water reuse project.

4.2 RO Concentrate Management

For projects that use RO, management of the RO concentrate stream is an important part of the permitting process. RO concentrate is the waste stream from an RO system, which treats water by using high-pressure pumps to push water through a semipermeable membrane. This membrane removes dissolved salts (TDS), particles, colloids, organic matter, and microorganisms from the feed water. The treated water (permeate) is sent to the next treatment process, while the waste stream (concentrate) is sent to a concentrate management system.

As an RO system rejects 95 to 99 percent of dissolved salts, this concentrate stream contains high levels of TDS that must be properly managed. There are various strategies for RO concentrate management. These strategies are currently being studied by the District, and a plan is currently being developed that will be incorporated into the Master Plan process as information becomes available. The strategies under consideration include sanitary sewer discharge, discharge into an existing or new outfall, treatment cells, evaporation ponds, and deep-well injection.

4.2.1 Sanitary Sewer Discharge

One strategy for RO concentrate management is discharge into an existing sanitary sewer system for treatment at a WWTP. This would require coordination with the managing utility, which may include acquiring an industrial discharge permit. Multiple costs are associated with this strategy, including those of a new sanitary sewer/treatment plant connection and the potential increase in unit treatment costs due to increased 5-day BOD_5 and TSS concentrations of the wastewater influent.

Potential downstream impacts to the collection system or WWTP should also be considered. High sulfate or chloride levels, i.e., >1,000 mg/L (Rimer et al. 2006) could cause corrosion within the pipeline, and RO concentrate may need to be discharged in locations where there is sufficient flow to provide dilution. Pollutant increases could also impact downstream WWTP operations, particularly increases in nutrients and trace metals. They could strain existing WWTP operations, impacting biological processes such as nitrification (Sawyer et al. 2016). These increases in concentrations in WWTP influent can also translate to increased concentrations in the effluent, which could challenge NPDES permit limits (e.g., by contributing to toxicity in the receiving water) or impact downstream advanced water treatment facilities. For example, increases in TDS could impact downstream potable RO systems and create a positive feedback loop.

4.2.2 Discharge Through an Outfall

Another strategy for RO concentrate management is discharge through an existing or new outfall. The benefit of this strategy is that it avoids impacts on downstream collection systems and WWTP processes. However, the viability of this strategy depends on the impact of the concentrate flow on pollutant concentrations or toxicity limits specified in an existing outfall's NPDES permit. Anticipated water quality concerns for RO concentrate disposal through existing outfalls include nutrients, TOC, TDS, and trace metals like copper and nickel. Metals are of particular concern because they typically have concentration-based limits. As wastewater effluents are diverted for water reuse, the available dilution volume to reduce the concentrations of these contaminants goes down, making NPDES compliance potentially challenging.

Construction of a new outfall could be a regional concentrate disposal solution. However, similar to using an existing outfall, it would require obtaining an NPDES permit and ensuring compliance with the Basin Plan. This strategy was examined in the *South Bay Water Recycling Strategic and Master Plan* (2014), and a location was identified in the South SF Bay that could provide a 10:1 dilution. This solution would not increase TDS concentrations within the existing sewer system, but would require the construction of a new pump station and pipeline.

4.2.3 Engineered Wetlands and Treatment Cells

RO concentrate could be managed and treated through engineered wetlands. A potential option for these wetlands is the South Bay Salt Pond Restoration Project (SBSPRP). Through a study by the City of Oxnard, it was demonstrated that engineered fresh and brackish water wetlands could reduce the concentrations of nutrients and trace contaminants in RO concentrate. Plants growing in the engineered wetlands reduced concentrations of dissolved organic carbon, nitrogen, ammonia, phosphorus, and trace metals through natural biological activity and adsorption (CH2M Hill 2007). If wetlands are designated as "treatment" wetlands, they would be permitted as part of the overall wastewater treatment process.

If necessary, additional pretreatment of open water treatment cells could be applied to further reduce pollutant loading. However, permitting for treatment cells could be challenging, as there would need to be coordination with the U.S. Army Corps of Engineers, Regional Board, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife, and the SF Bay Conservation and Development Commission.

Treated RO concentrate from treatment cells and engineered wetlands would have to be conveyed to another location for ultimate disposal; however, this management strategy could potentially be combined with another disposal option—e.g., the RO concentrate could be treated via engineered wetland before being discharged through a Bay outfall. The wetland would reduce RO concentrate pollutant concentrations and toxicity, potentially maintaining effluent concentrations below the NPDES permit limits.

Another approach is to leverage engineered wetlands for natural tidal wetlands restoration, and use the natural tides to flush the RO concentrate. However, the natural TDS concentrations for RO concentrate may not be high enough and may have to be increased to develop a natural saltwater marsh (RMC and CDM Smith 2014). Discharging treated effluent from an engineered wetland to natural wetlands would also require a new NPDES permit.

4.2.4 Evaporation Ponds

Another strategy is evaporation ponds, either with or without mechanical enhancement. The advantages of evaporation ponds include simple operation and the diversion of RO concentrate from the SF Bay. However, evaporation ponds require large areas of land, which is challenging in the highly urban areas around South SF Bay. The *South Bay Water Recycling Strategic and Master Plan* calculated that land requirements would be about 1,400 acres per 1 mgd of RO concentrate without mechanical enhancement and 500 acres per 1 mgd with mechanical enhancement (RMC and CDM Smith 2014). For permitting requirements, the development of an evaporation pond would be included in the application of an NPDES permit or WDR permit. Any existing NPDES or WDR permits would be subject to revision and re-approval by the Regional Board.

4.2.5 Deep-Well Injection

Deep-well injection is another management strategy that would divert RO concentrate from the SF Bay. The concentrate would be injected into a deep confined aquifer under pressure, and the injection zone would be selected to prevent impacts to any drinking water aquifers (or any other beneficial uses). This option is viable only in areas where the hydrogeological conditions are favorable, and no suitable aquifers have been readily identified in the South SF Bay area to date. For permitting, the State of California has primacy for Class II – oil and gas related wells; all other injection wells are regulated by the EPA and must be registered through the federal Underground Injection Control program.

4.3 Backwash Streams

The strategy chosen for managing the backwash streams generated by PR treatment can impact pathogen reduction credit. Typically, backwash streams (e.g., from MF backwashing) are either recycled to the WWTP headworks or discharged to the sewer. However, additional drivers may be present to deal with backwash streams in a different way. For example, at the Leo J. Vander Lans Water Treatment Facility, limitations on sewer discharge resulted in implementation of a secondary MF to increase the overall MF recovery. This setup resulted in a reduction of protozoa removal credit through the MF system. In addition, in the context of drinking water treatment, the *Cryptosporidium Action Plan* limits both the quality and quantity of backwash water that can be recycled to the headworks of a drinking water treatment plant. This type of restriction may be placed on AWTFs recycling their backwash streams to the WWTP headworks. These considerations should be taken into account when designing NPR and PR treatment trains.

4.4 NEPA/CEQA Implications

As projects seek funding via grants or loans from the State Board through the State Revolving Fund (SRF) Loan Program, Proposition 1 funds, or under Title XVI under the U.S. Bureau of Reclamation, compliance with the environmental requirements under NEPA (federal) and CEQA (state) may be required. There are opportunities to do a combined NEPA/CEQA document to streamline schedule and permitting.

4.4.1 NEPA Requirements

Compliance with NEPA is required if pursuing Title XVI funding. NEPA requires federal agencies to assess the environmental, social, and economic effects of any proposed actions. A NEPA Environmental Assessment (EA) should address NEPA requirements, including the following:

- **Federal Endangered Species Act**: A Biological Assessment (BA) Report will need to be prepared for the State Board for use to confer informally with USFWS and/or the National Marine Fisheries Service about potential impacts of federally listed species due to the construction and operation of the project. The BA will address species listed under the federal Endangered Species Act (ESA) that could be within the project area and the likelihood of the project adversely affecting those resources.
- **Federal General Conformity Rule for the federal Clean Air Act**: An analysis will need to be done to determine if a project's emissions and greenhouse gases are in general conformity with the federal Clean Air Act. The determination of conformity is a two-step process consisting of (1) applicability analysis and (2) conformity analysis. The applicant will conduct the analysis by comparing the project's emissions to the minimum pollutant thresholds outlined in the conformity rule.
- **National Historic Preservation Act**: A Cultural Resources Inventory Report will need to be prepared to comply with Section 106 of the National Historic Preservation Act of 1966. The criteria for determining the significance of impacts to cultural resources is the significance of the cultural resources themselves, as defined by the National Register Criteria (Code of Federal Regulations [CFR] Title 36 Part 60.4). This study will consist of an archaeological inventory of cultural surveys and archaeological reports, contacts with Native Americans, as well as a cursory reconnaissance survey of the proposed project area.
- **Socioeconomics**: Any adverse socioeconomic effects, Indian Trust Assets (property rights held in trust by the U.S. government), and any effects on low-income populations (per Environmental Justice Executive Order 12898) must be identified.

4.4.2 CEQA Requirements

CEQA provides the basis to protect environmental quality in the state of California. CEQA requires State and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. All public agencies must comply with CEQA when they undertake an activity defined as a "project." A project is an activity undertaken by a public agency or private activity that must receive an approval from a government agency that "has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect change in the environment" (CCR, Section 15378).

Most proposals for physical development in California are subject to the provisions of CEQA, including actions involving the discharge of highly treated wastewater for recycled water applications or discharge of residuals. Every development project that requires discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. At a minimum, an initial review of the project and its environmental effects must be conducted. Depending on the potential effects, a further, and more substantial, review may be conducted in the form of an environmental impact report (EIR).

The review process to meet CEQA requirements should begin as soon as the recommended project elements are defined, as the process can be lengthy. Guidelines for the implementation of the CEQA process are included in CCR, Title 14, Section 3, and are also summarized in Figure 4-1.

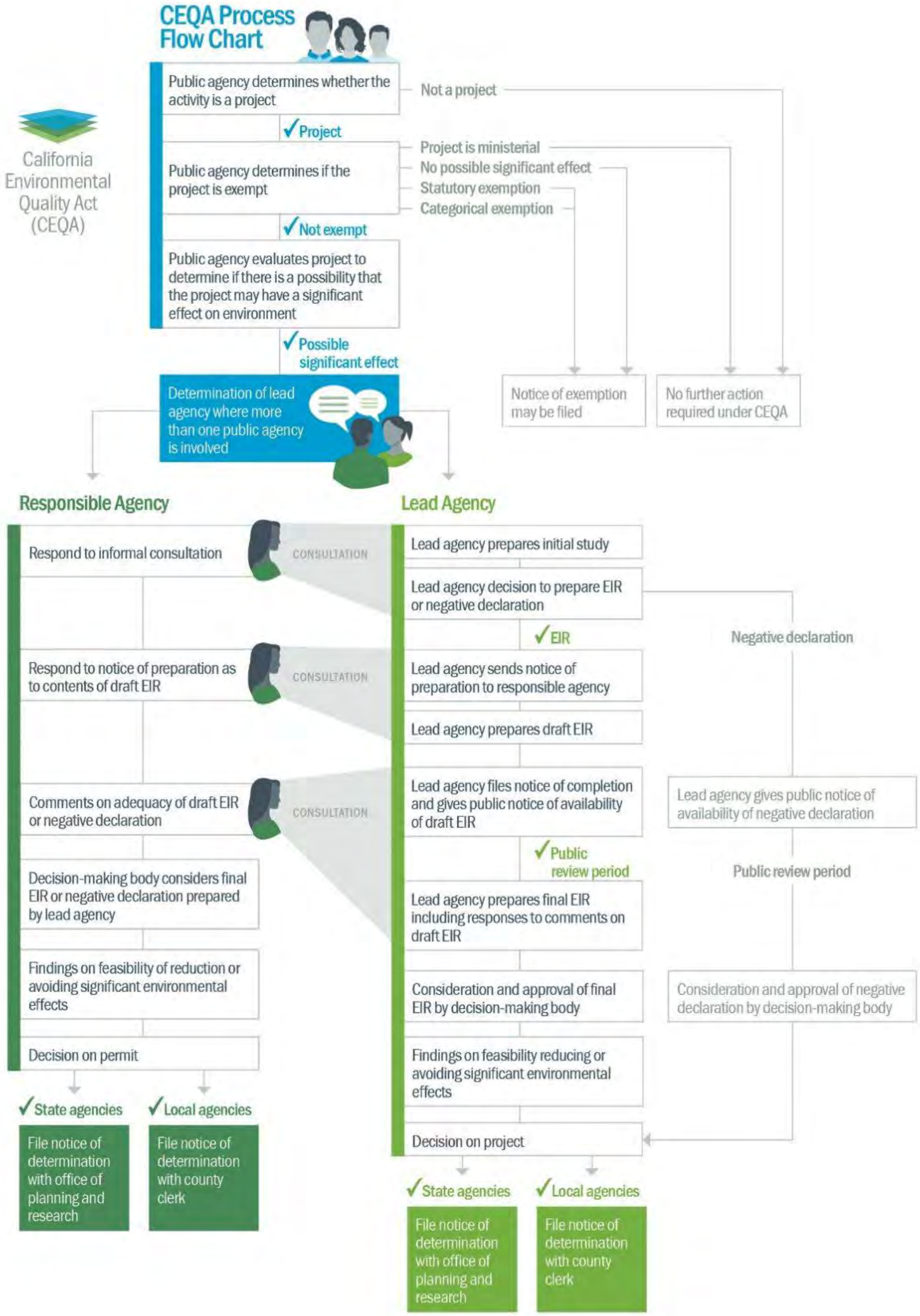

CEQA Process Flow Chart
California Environmental Quality Act (CEQA)
Public agency determines whether the activity is a project
Not a project
✓ Project
Public agency determines if the project is exempt
Project is ministerial
No possible significant effect
Statutory exemption
Categorical exemption
✓ Not exempt
Public agency evaluates project to determine if there is a possibility that the project may have a significant effect on environment
✓ Possible significant effect
Notice of exemption may be filed
No further action required under CEQA
Determination of lead agency where more than one public agency is involved
Responsible Agency
Lead Agency
Respond to informal consultation
CONSULTATION
Lead agency prepares initial study
Lead agency decision to prepare EIR or negative declaration
✓ EIR
Negative declaration
Respond to notice of preparation as to contents of draft EIR
CONSULTATION
Lead agency sends notice of preparation to responsible agency
Lead agency prepares draft EIR
Comments on adequacy of draft EIR or negative declaration
CONSULTATION
Lead agency files notice of completion and gives public notice of availability of draft EIR
Lead agency gives public notice of availability of negative declaration
✓ Public review period
Public review period
Decision-making body considers final EIR or negative declaration prepared by lead agency
Lead agency prepares final EIR including responses to comments on draft EIR
Findings on feasibility of reduction or avoiding significant environmental effects
Consideration and approval of final EIR by decision-making body
Consideration and approval of negative declaration by decision-making body
Decision on permit
Findings on feasibility reducing or avoiding significant environmental effects
✓ State agencies
✓ Local agencies
File notice of determination with office of planning and research
File notice of determination with county clerk
Decision on project
✓ State agencies
✓ Local agencies
File notice of determination with office of planning and research
File notice of determination with county clerk

Figure 4-1. CEQA process flow chart

Source: Adapted from California Natural Resources Agency, 2013.

4.4.3 CEQA-Plus Requirements

If SRF financing is planned for the project, federal agencies are afforded the opportunity to review the environmental documents. This initiates the “CEQA-Plus” process, which requires the project to meet additional federal requirements, some of which are described in Section 4.4.1 (NEPA Requirements). CEQA-Plus requirements include compliance with the following regulations:

- Section 7 of the federal ESA
- Section 106 of the National Historic Preservation Act
- Federal Clean Air Act
- Migratory Bird Treaty Act
- Wild and Scenic River Act
- Protection of Wetlands
- Floodplain Management
- Farmland Protection Policy Act
- Coastal Zone Management Act

Section 5: Future Policy Recommendations

This section is a placeholder to tee up concepts for considerations throughout the project. Policy recommendations will be incorporated into the Draft Master Plan.

5.1 Opportunities for Unified Local Policies

This section is a placeholder for any potential unified local policies. This could include a discussion on onsite reuse, and the information and gaps surrounding its regulation (San Francisco Public Utilities Commission [SFPUC] ordinance, SB 966 – Weiner Bill).

5.2 Other Potential New Policies

This section is a placeholder for any potential new policies. This could include a discussion of recommended new policies that could facilitate implementation of the Master Plan.

Section 6: References

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Appendix C-1: Modeling Plan and Results

741 Allston Way
Berkeley, CA 94710

T: 510-540-7100

Prepared for:	Santa Clara Valley Water District
Project Title:	Countywide Water Reuse Master Plan
Project No.:	4821 (Valley Water); 151772 (BC)
Contract No.:	A4120A

Appendix C-1

Subject:	Modeling Plan and Results
Date:	October 13, 2020
To:	Miguel Silva, Valley Water Project Manager
From:	Jenny Gain, PE, Brown and Caldwell Team Project Manager
Copy to:	David Tucker, Valley Water Assistant Project Manager

Prepared by:	Navina Venugopal, EIT, HydroScience Engineers
Reviewed by:	Curtis Lam, PE, HydroScience Engineers California License: C59049

Table of Contents

Section 1: Introduction 1
1.1 Background 1
Section 2: Data Request 3
Section 3: Existing Model Development 4
3.1 Updated Model Networks 4
3.2 Demands 5
  3.2.1 Diurnal Patterns 5
  3.2.2 Average Day and Maximum Day 5
3.3 Calibration 5
  3.3.1 Calibration Data 5
3.4 Regional Connections 6
Section 4: Existing Model Criteria 6
Section 5: Purified Water Models 8
5.1 Model Criteria 8
5.2 Hydraulic Results and Analysis 8

List of Figures

Figure 1. Existing water reuse wholesalers, producers, and retailers in Santa Clara County 2
Figure 2. Facility locations and pipeline alignments for Portfolio 1A 11
Figure 3. Facility locations and pipeline alignments for Portfolio 1B 12
Figure 4. Facility locations and pipeline alignments for Portfolio TWA 1C 13
Figure 5. Facility locations and pipeline alignments for Portfolio TWA 1D 14
Figure 6. Facility locations and pipeline alignments for Portfolio 2A 15
Figure 7. Facility locations and pipeline alignments for Portfolio 2B 16
Figure 8. Facility locations and pipeline alignments for Portfolio 4 17
Figure 9. Facility locations and pipeline alignments for Westside TWA (7A) 18
Figure 10. Facility locations and pipeline alignments for Morgan Hill Option 2 19
Figure 11. Facility locations and pipeline alignments for Morgan Hill Option 3 20

List of Tables

Table 1. Data Request Summary 3
Table 2. City of Palo Alto Model Criteria Summary 6
Table 3. City of Sunnyvale Model Criteria Summary 6
Table 4. SBWR Model Criteria Summary 7
Table 5. SCRWA Model Criteria Summary 7
Table 6. Design Criteria Summary 8
Table 7. InfoWater Pump Results 7
Table 8. InfoWater Pipe Results 8
Table 9. Hydraulic Grade Line Data 10

Section 1: Introduction

This Modeling Plan describes how Project team members propose to update and use hydraulic models as part of Santa Clara Valley Water District's (Valley Water) Countywide Water Reuse Master Plan (CoRe Plan) for Santa Clara County (County), as part of contract A4120A, Schedule P, Task 5.2.

1.1 Background

Valley Water owns, operates, and maintains three drinking water treatment plants (Rinconada, Santa Teresa, and Penitencia), the Silicon Valley Advanced Water Purification Center (SVAWPC), nearly 400 acres of groundwater recharge ponds, and 10 dams. Within the County, there are 13 major water retailers (California Water Service Company, City of Gilroy, Great Oaks Water Company, City of Milpitas, City of Morgan Hill, City of Mountain View, City of Palo Alto, Purissima Hills Water District, San José Municipal Water System, San Jose Water, City of Santa Clara, Stanford University, and the City of Sunnyvale). Of these, nine currently distribute recycled water through more than 180 miles of pipelines. Recycled water is produced at four regional wastewater treatment facilities, which include the San José/Santa Clara Regional Wastewater Facility, the Palo Alto Regional Water Quality Control Plant, the City of Sunnyvale Water Pollution Control Plant, and the South County Regional Wastewater Authority (SCRWA) Treatment Plant. These facilities and their recycled water infrastructure are shown in Figure 1.

Valley Water collaborates with four Partner Agencies: City of Palo Alto, City of Sunnyvale, South Bay Water Recycling (SBWR), and SCRWA. The modeling effort is part of Task 5, the feasible project alternatives task of the CoRe Plan. Task 5.2 focuses on the hydraulic and water quality modeling. Existing models for the Palo Alto/Mountain View Recycled Water System (RWS), Sunnyvale RWS, SBWR, and South County RWS will serve as a starting point for the CoRe Plan modeling effort. This modeling plan and results TM identifies how these existing hydraulic models have been updated to reflect the most current existing systems and demands and to evaluate conceptual and feasible project alternatives. Additional scenarios were also identified to reflect available planning information, user data, future system goals, and future system requirements.

It was noted that total dissolved solids (TDS) simulations were not performed using the hydraulic model, since it is anticipated that any NPR system that interties with another system is expected to have similar recycled water quality.

Following definition and confirmation of the alternatives, the models were calibrated and validated, and a Quality Assurance/Quality Control calibration of the final model simulations was performed.

This memorandum presents the results of purified water modeling for the portfolios included in the CoRe Plan. This modeling plan documents the development and findings from the hydraulic models, including parameters, model calibration, proposed infrastructure, a hydraulic grade line data table for each potential system, and infrastructure sizing results. For more information about the details of each portfolio, please refer to Sections 5 and 6 of the CoRe Plan.

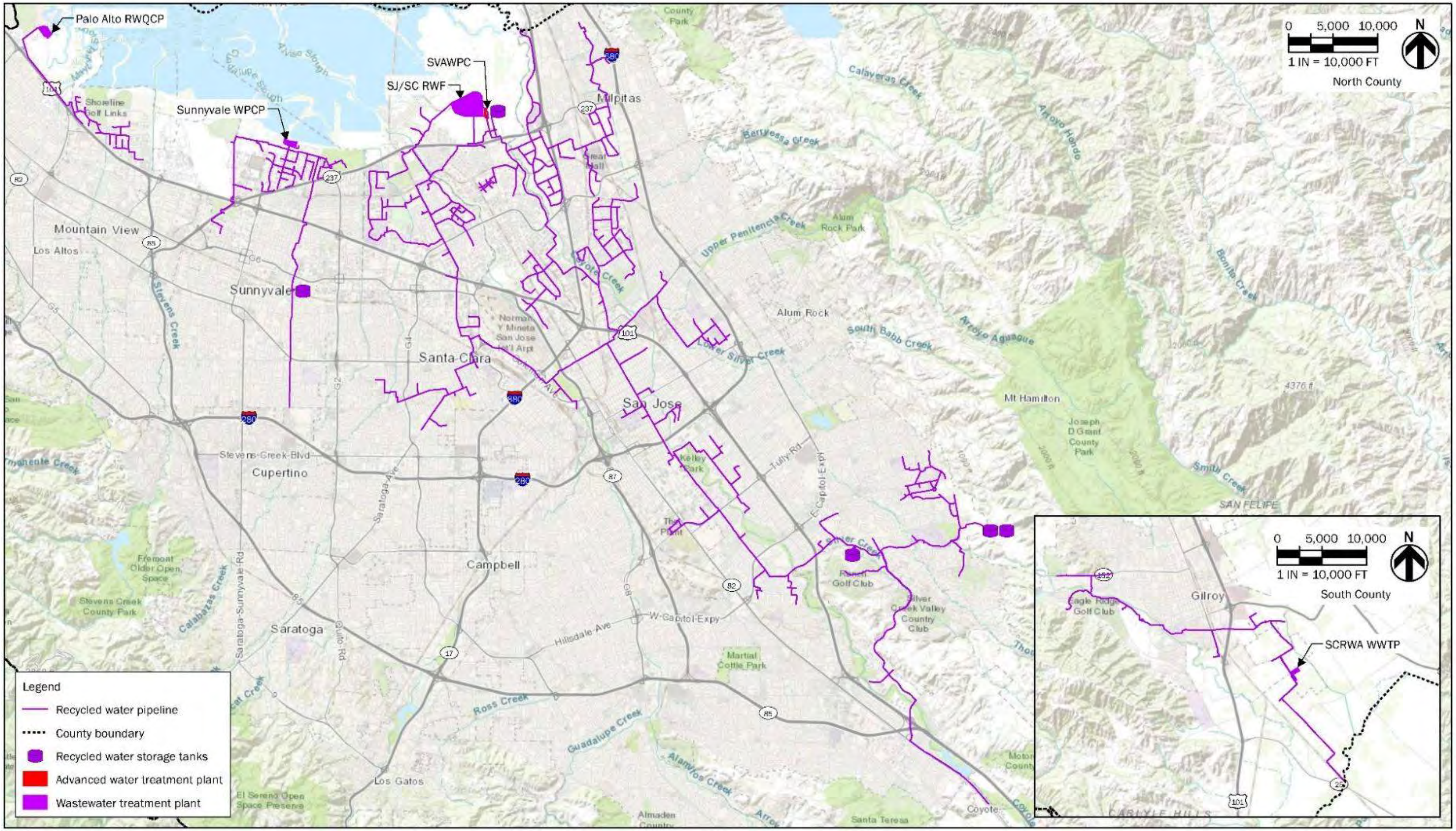


Figure 1. Existing recycled water systems in Santa Clara County

Section 2: Data Request

Updating the model networks and demands for the Partner Agency RWS hydraulic models required data from each entity. Table 1 summarizes requests for network, demand, calibration, operation, and planning/coordination data.

Table 1. Data Request Summary

Data		Requested for and from			
No.	Description	City of Palo Alto	City of Sunnyvale	SBWR	SCRWA
Network					
1	Plans and data for distribution pipes constructed after models were last updated: • Example: SVAWPC for SBWR model • All current GIS shapefiles of system infrastructure	X	X	X	X
Demands					
2	Database of the existing users and meter reads: • 2017 is the period of data that is recommended if data is available, since prior year demands might be impacted more by the drought	X	X	X	X
Calibration					
3	Flow data and operational criteria for source water: • Available flow data (supervisory control and data acquisition [SCADA] or otherwise) for source water and operational criteria for facilities, preferably in electronic tabular format in hourly time steps	X	X	X	X
4	2015-2017 SCADA data for available locations: • Maximum Day Demand condition will be the most informative scenario as it relates to system capacity and operations, ideally this data would come from selected days during June, July or August of 2017 if available. Tank level information, pump and booster station flow data, and pressure data for a period of up to 3 weeks, minimum of a week	X	X	X	X
5	Diurnal use pattern information: • Please provide any known information on recommended and restricted hours of use for customers	X	X	X	X
6	Refined flow data: • Refined flow data could include mag meter flow data from pump stations • Particularly interested in largest customers and whether these customers are industrial users	X	X	X	X
7	Guidance on customers usage patterns: • Some customers may have unique diurnal flow patterns that may be worth creating separate demand patterns for their flow. Provide any specific data (hourly flows, pressures, or other data) that is available for us to create a separate demand pattern	X	X	X	X
8	Pressure data loggers availability: • Confirm how many Pressure Data Loggers are available for use and that staff is available for installation during calibration			X	X

Table 1. Data Request Summary

Data		Requested for and from			
No.	Description	City of Palo Alto	City of Sunnyvale	SBWR	SCRWA
Operation					
9	Customers with on-site impoundments/storage: • List and provide location of customers that store recycled water in on-site impoundments			X	X
10	Operational/system control data: • Control set points, operational parameters, and logical controls used within the system to automate various infrastructure (i.e. tanks, pump stations, pressure reducing valves, etc.)	X	X	X	X
Planning/Coordination					
11	Confirm future planning demand estimates and scenarios available and any new/planned recycled water infrastructure: • Or identify if we are instead to reference an UWMP • Identify critical timelines of construction of elements that will affect customer connections or water availability	X	X	X	X
12	Schedule availability for meeting: • Confirm how the system is currently operating • Confirm that the model reflects current operating strategy • Discuss any remaining items of clarification	X	X	X	X

Section 3: Existing Model Development

Each of the existing Partner Agency models was updated separately using information about model networks and demands provided by the Partner Agencies.

3.1 Updated Model Networks

Existing model networks for the four Partner Agencies was updated to reflect current conditions based on current GIS shapefiles, or record/design drawings available of improvements or expansions. The four partner agencies have a total of five existing models. Each is briefly described below.

SBWR: The SBWR recycled water model was last updated in 2015, but did not include an up-to-date model network. Required updates include: updating demands with 2017 meter data to be consistent across all agencies/models, adding additional pipelines constructed since 2010, and modifying the influent source water portion of the model to reflect construction of the SVAWPC. The SBWR hydraulic model utilizes InfoWater software.

Sunnyvale: The Sunnyvale recycled water model was last updated as part of the *Feasibility Study for Recycled Water Expansion* in 2013. Required updates include: updating demands with 2017 meter data to be consistent across all agencies/models, adding additional pipelines constructed since 2013, and modifying the existing San Lucar pump station to reflect recently constructed upgrades. The Sunnyvale hydraulic model utilizes InfoWater software.

SCRWA: The SCRWA recycled water model was last updated as part of the *2015 South County Recycled Water Master Plan Update*. Updates required include: updating demands with 2017 meter data to be consistent across all agencies/models, and adding additional pipelines constructed since 2015. The SCRWA hydraulic model utilizes InfoWater software.

Palo Alto/Mountain View: Palo Alto/Mountain View is a single RWS with two separate hydraulic models. The first model was updated in 2017 as part of the *Palo Alto Recycled Water Strategic Plan* and expanded the existing system into Palo Alto. Demands in the existing Mountain View portion of the system are simulated with a single demand node based on pump station records and will need to be updated. This model utilizes InfoWater software. The second model is an updated version of the existing Mountain View system only. A copy of this model was received from City of Mountain View in July 2018.

3.2 Demands

Recycled water demands were updated for each of the Partner Agency models separately based on available meter data. Data received from the retailers were for the summer months (June through August) of 2017, as earlier years may reflect drought use patterns. Using each agencies geolocated meter shapefile and the InfoWater software, these updated meter demands will be allocated to the nearest node in the model.

3.2.1 Diurnal Patterns

Separate diurnal demand curves will be assigned for industrial and irrigation users for the extended period model simulations. When available, unique use patterns for large users were used. The diurnal curves used in the existing models were updated based on flow data provided by each retailer. Diurnal patterns were used to identify hours of use and to estimate peak hour demands for each RWS. Although irrigation customers are not likely to irrigate over the entire period allowable for irrigation, this will account for the fact that customers irrigate at different times. The diurnal curves will be calibrated using SCADA pump station data as well as flow into and out of system storage facilities.

Where possible, industrial users will be classified separately, as they are likely to utilize the water during the business day, while irrigation use occurs in restricted evening hours.

3.2.2 Average Day and Maximum Day

The meter data will be used to estimate an average day and a max day demand in gallons per minute (gpm). The average day will be calculated based on the total volume used in a year divided by the number of days per year that the recycled water is used. For example, the number of days per year for industrial users may be business days only. For irrigation users, it will be assumed that irrigation does not occur during wet weather unless otherwise known. Maximum day demands will be identified as the maximum daily demand during the dry period.

3.3 Calibration

Model calibration compares actual field data/measurements to results generated by the hydraulic model. Then adjustments are made to the model such that results predicted by the hydraulic model accurately represent the conditions within the system. 15-minute pressure data, tank levels, and flows from the pump stations, booster stations, and storage facilities will be reviewed if available or recorded for a week in order to validate, adjust, create, and/or modify the model as part of the calibration process. The goal is to match within +/- 10-15 percent of the measured data. Diurnal patterns, pipe roughness, and operational controls all may be adjusted during calibration.

3.3.1 Calibration Data

For 2015-2017, calibration data will need to be at hourly intervals, though 15-minute intervals are preferred. Additionally, at least a week of SCADA data will be required during field calibration in June or July. Data during this period will include:

- Pressure data from pressure loggers installed at various locations (air release valves and meters, or other available points of access) within the distribution system. Should Partner Agencies own pressure loggers, those will be used. Otherwise, Dickson PR350 small pressure data loggers are recommended.
- SCADA data in Microsoft Excel or Microsoft database format if available:
  - Storage tank levels
  - Flow from the treatment plant
  - Flows at the pump stations

3.4 Regional Connections

Three of the four partner agencies (Palo Alto, Sunnyvale and SBWR) are located in close enough proximity to make the interconnection of non-potable water systems feasible. However, since no interties were included in any portfolio that was modeled, NPR systems will not be interconnected in the hydraulic model.

Section 4: Existing Model Criteria

The modeling criteria mirrors system design criteria and varies by Partner Agency in value and content. Tables 2 through 5 summarize the criteria used to develop the existing models for each Partner Agency Overall demand quantities are being updated as part of this modeling effort. In addition, peak demand criteria (month, day, and hour) may be replaced after more recent meter data is reviewed.

To the extent feasible, the model criteria within each system remained the same.

Table 2. City of Palo Alto Model Criteria Summary

Criteria	Value
Minimum pressure at customer connections	65 psi
Maximum pressure	180 psi
Minimum pipe size for backbone alignment	6 inches
Maximum head loss	5 feet per 1,000 feet of pipe
Velocity	2-8 fps

Source: City of Palo Alto Recycled Water Facility Plan, (RMC, 2008)

psi = pounds per square inch

fps = foot/feet per second

Table 3. City of Sunnyvale Model Criteria Summary

Criteria	Target Value	Criteria Limit
Maximum pressure	105 psi	150 psi
Minimum pressure	60 psi	40 psi
Pipe head loss	10 feet per 1,000 feet of pipe	15 feet per 1,000 feet of pipe
Maximum pipeline velocity	7 fps	7 fps
Hazen-Williams Coefficient (C)	120	

Table 3. City of Sunnyvale Model Criteria Summary

Criteria	Target Value	Criteria Limit
Irrigation period	9:00 PM to 6:00 AM (9 hours)	
Peak day demand (PDD)	= 2.4 x Average Day Demand (ADD)	
Peak hour demand (PHD)	= 2.67 x PDD	
Operational reservoir storage	PDD	
Pump Station – Design Capacity	PHD	
Pump Station – Minimum Number of Pumps	3	

Source: Sunnyvale Feasibility Study for Recycled Water Expansion, (HydroScience, 2013)

Table 4. SBWR Model Criteria Summary

Criteria	Value
Peak Month	= 1.5 x ADD
PDD	= 1.7 x ADD
Peak Hour	= 1.4 x PDD

Source: 2014 SBWR, Strategic and Master Planning Vol. 1 and Vol. 2, (RMC, 2014)

Table 5. SCRWA Model Criteria Summary

Criteria	Value
Minimum Pressure	35 psi
Normal Pressure Range	60-120 psi
Pipe Head Loss	<4 feet per 1,000 feet of pipe
Pipe Velocity	<5 fps

Source: 2015 South County Recycled Water Master Plan Update, (MWH/Akel, 2016)

Section 5: Purified Water Models

This section provides an overview of the hydraulic modeling performed for the feasible purified water portfolios and options outlined in the CoRe Plan, which use source water from the San José-Santa Clara Regional Wastewater Facility, Sunnyvale Water Pollution Control Plant, Palo Alto Regional Water Quality Control Plant, and a satellite Advanced Water Purification Facility in Morgan Hill. The model results define infrastructure sizing for the proposed treated water systems and provide a basis for the volume of purified water that can be utilized.

5.1 Model Criteria

HydroScience analyzed all portfolios using InfoWater by Innovyze software. Table 6 summarizes the criteria used to develop the facility sizing. The design criteria remain the same throughout all models, with the exception of assumed outlet pressure; the assumed outlet pressure is 100 psi at Valley Water treated water pipeline delivery points and 25 psi at bodies of water (lakes/reservoirs, ponds). Elevations for the distribution system components were obtained from USGS 2020 1/3 Arcsecond Digital Elevation Models (DEMs).

Table 6. Design Criteria Summary

Criteria	Value
Minimum Pressure	25 psi
Pipe Head Loss	<10 feet per 1,000 feet of pipe
Pipe Velocity	<7 fps
Hazen-Williams Coefficient (C)	130[1]
Efficiency	65%
Safety Factor	10%

Notes:

1. Pipes are assumed to be Ductile Iron Pipes.

5.2 Hydraulic Results and Analysis

Pump and pipe sizing based on the model results is summarized in Tables 7 and 8. Table 9 summarizes the hydraulic grade line data for each pump. The infrastructure required for each purified water system identified in this modeling was used to estimate construction cost estimates for each portfolio in the CoRe Plan.

The model determined the actual total dynamic head (TDH) and horsepower requirements required to deliver purified water from the pump station to the delivery point. These numbers were modified to include an assumed pump efficiency of 65% and a 10% safety factor. This resulted in a calculated horsepower in excess of what was modeled, which is intended to more closely represent what may actually be designed. It was also noted that the pump stations and pipelines will be sized to deliver a value that is consistent with the capacities shown in the tables below and in the CoRe Plan.

The modeled facilities are shown in Figures 2 through 10.

Table 7. InfoWater Pump Results

Option	Pump	Average Annual Flow (gpm)	TDH (ft)	Calculated HP[1]
Portfolio 1a	PS-1	16,667	400	2,877
Portfolio 1b	PS-2	16,667	550	3,977
Portfolio TWA 1c	PS-14	16,667	350	2,500
Portfolio TWA 1c	PS-15	8,333	250	890
Portfolio TWA 1d	PS-15	8,333	250	890
Portfolio TWA 1d	PS-16	16,667	350	2,500
Portfolio 2a	PS-3	12,152	100	508
Portfolio 2a	PS-4	8,000	100	400
Portfolio 2a	PS-5	16,667	400	2,877
Portfolio 2b	PS-6	12,152	100	508
Portfolio 2b	PS-7	16,667	400	2,877
Portfolio 4	PS-9	9,722	400	1,650
Portfolio 4	PS-3	12,152	100	508
Portfolio 4	PS-10	6,944	400	1,400
Westside TWA (7a)	PS-18	16,667	500	3,570
Morgan Hill Option 2	MHPS-3	1,458	125	78
Morgan Hill Option 3	MHPS-1	1,458	500	279
Morgan Hill Option 3	MHPS-2	1,458	350	218

Notes:

1. Horsepower (HP) calculated with 65% pump efficiency and 10% safety factor.

Table 8. InfoWater Pipe Results

Option	Pipe	Size (in)	Length (ft)	Velocity (fps)	Head Loss (ft)
Portfolio 1a	PL-2	48	95,490	2.96	52
Portfolio 1b	PL-4	48	47,100	2.96	26
Portfolio TWA 1c	PL-40	36	20,800	5.25	46
Portfolio TWA 1c	PL-41	24	24,700	5.91	109
Portfolio TWA 1d	PL-42	36	43,100	5.25	95
Portfolio 2a	PL-5	36	15,150	3.83	18
Portfolio 2a	PL-6	36	38,820	2.52	23
Portfolio 2a	PL-7	48	107,400	2.96	58

Portfolio 2b	PL-8	36	52,950	3.83	67
Portfolio 2b	PL-9	48	90,230	2.96	49
Portfolio 4	PL-10	36	34,500	2.98	27
Portfolio 4	PL-11	48	72,500	2.96	41
Portfolio 4	PL-12	36	11,400	2.27	5
Westside TWA (7a)	PL-44	36	56,600	5.25	125
Morgan Hill Option 2	PL-25	16	14,600	2.33	19
Morgan Hill Option 3	PL-26	16	29,400	2.33	32

Table 9. Hydraulic Grade Line Data

Portfolio	Pump	Elevation at Point of Discharge (ft)	Elevation at Point of Delivery (ft)	TDH (ft)
Portfolio 1a	PS-1	10	314	400
Portfolio 1b	PS-2	10	500	550
Portfolio TWA 1c	PS-14	13	261	350
Portfolio TWA 1c	PS-15	12	75	250
Portfolio TWA 1d	PS-16	14	437	350
Portfolio 2a	PS-3	11	67	100
Portfolio 2a	PS-4	5	69	100
Portfolio 2a	PS-5	10	314	400
Portfolio 2b	PS-6	11	69	100
Portfolio 2b	PS-7	5	313	400
Portfolio 4	PS-9[1]	10	314	400
Portfolio 4	PS-10[1]	10	314	400
Westside TWA (7a)	PS-18	10	385	500
Morgan Hill 2	MHPS-3	314	422	125
Morgan Hill 3	MHPS-1	314	657	500
Morgan Hill 3	MHPS-2	596	943	350

Notes:

1. *PS-9 and PS-10 deliver water to the same location.*

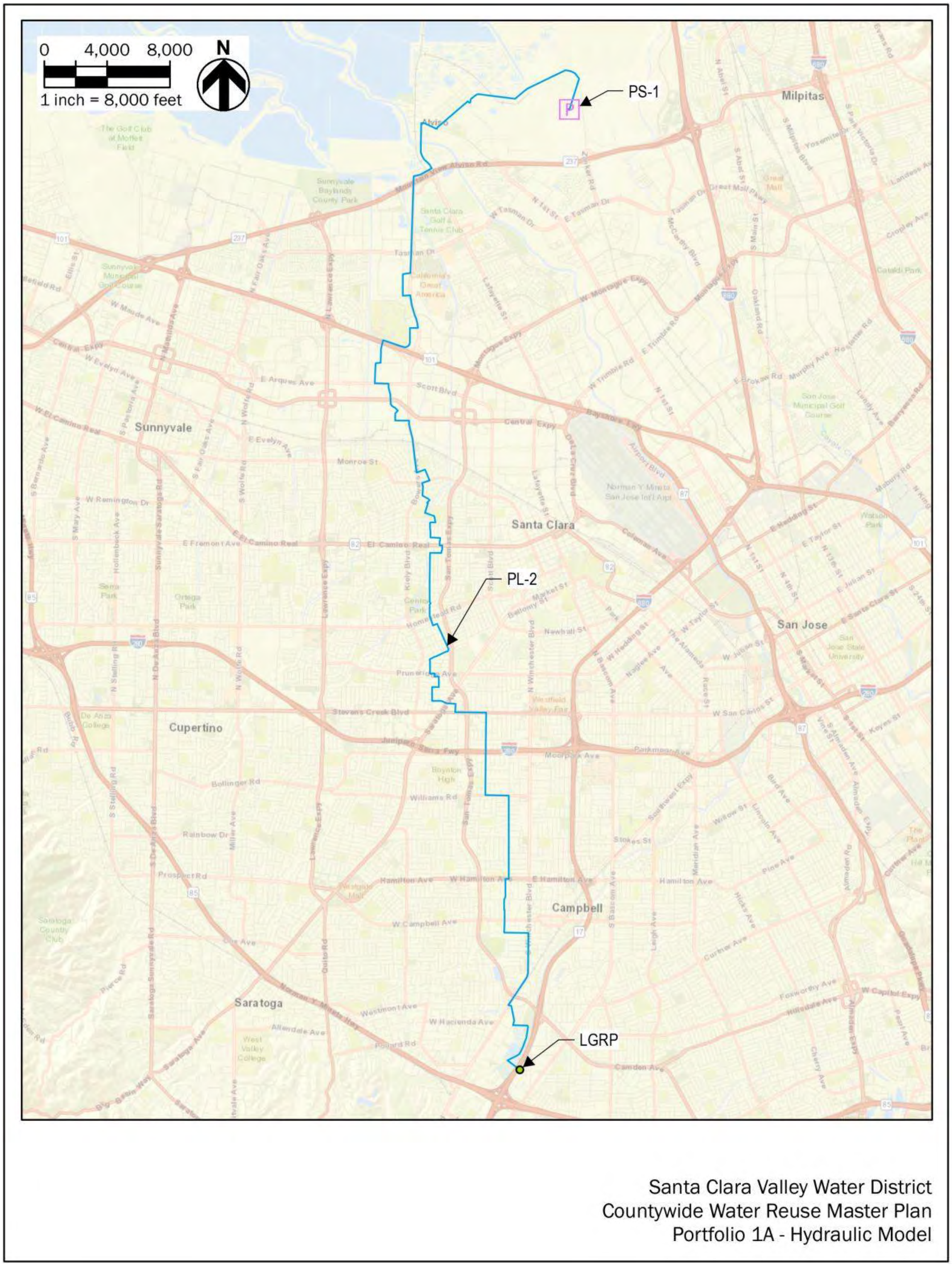
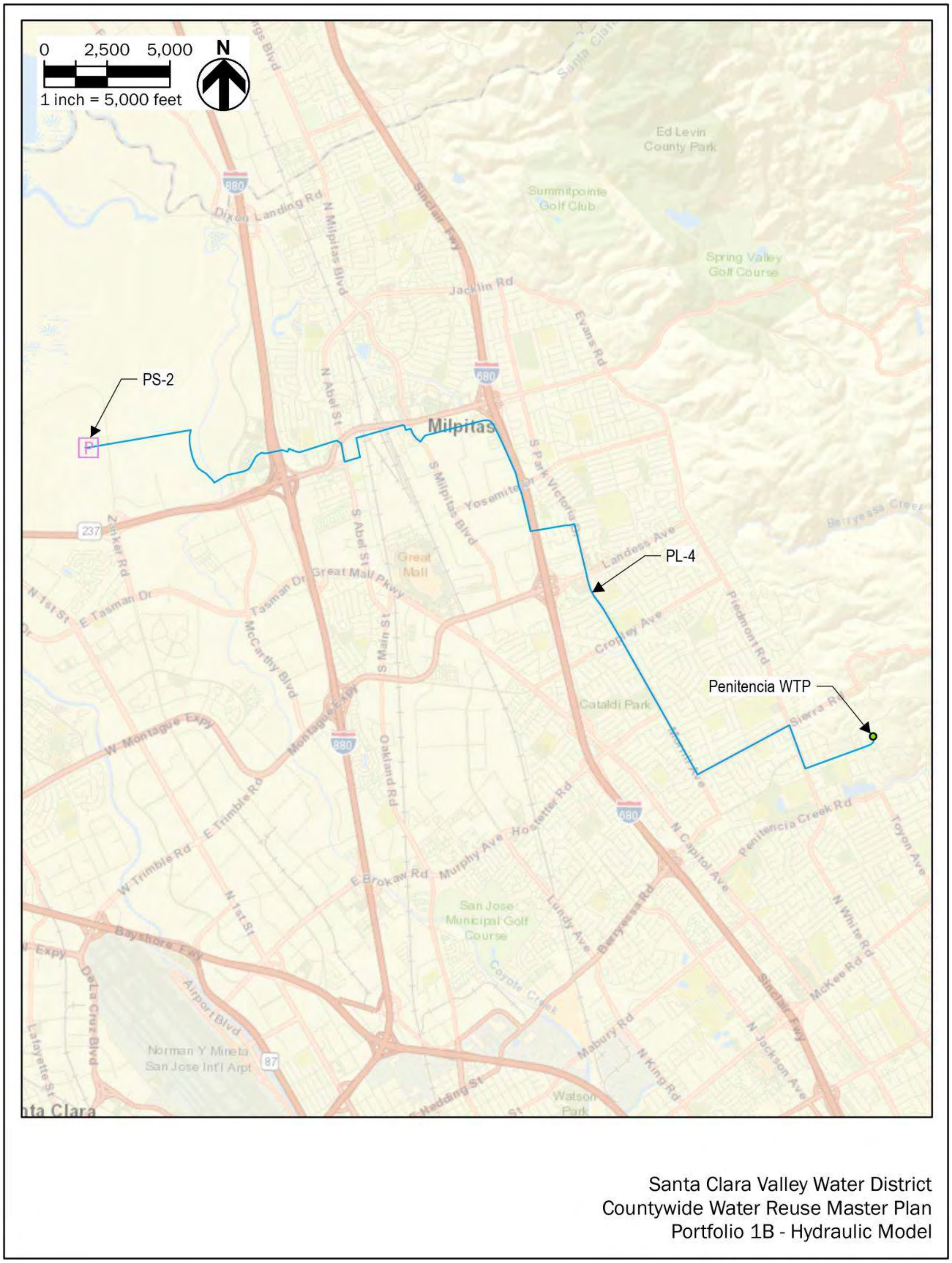


Figure 2. Facility locations and pipeline alignments for Portfolio 1a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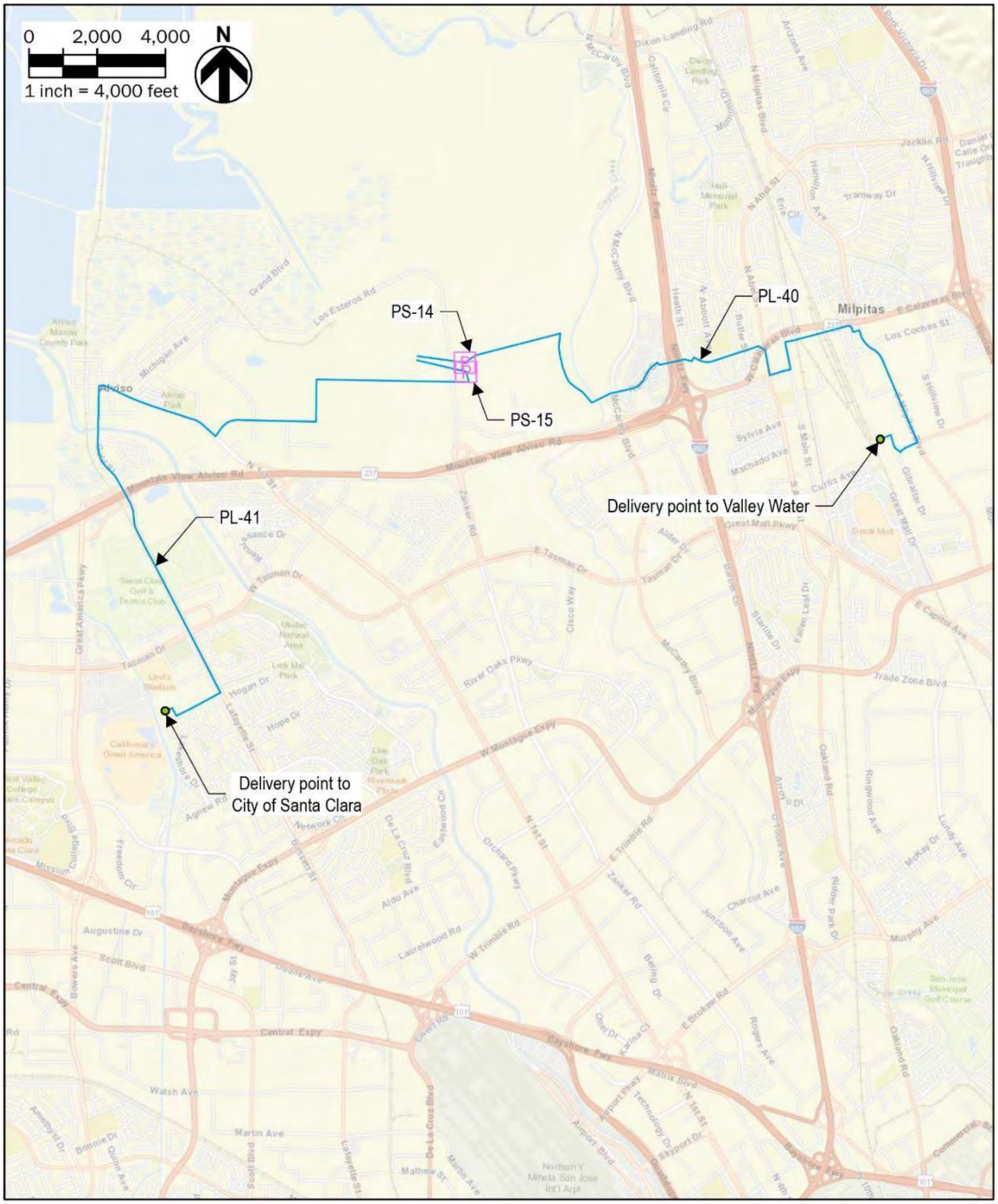
PL-4
Penitencia WTP
Milpitas
Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio 1B - Hydraulic Model

Figure 3. Facility locations and pipeline alignments for Portfolio 1b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Delivery point to Valley Water
Delivery point to City of Santa Clara
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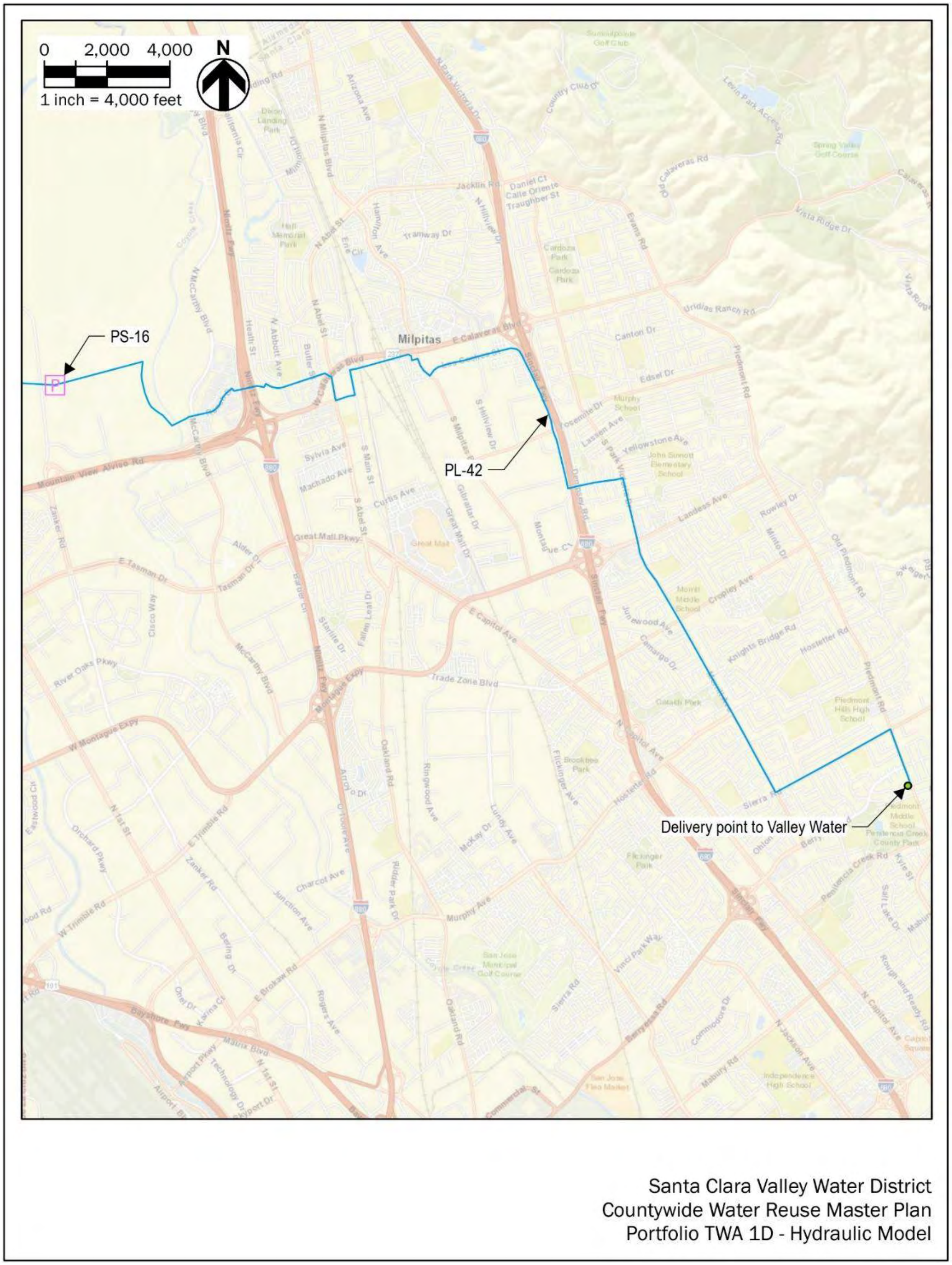
Milpitas

Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio TWA 1C - Hydraulic Model

Figure 4. Facility locations and pipeline alignments for Portfolio TWA 1c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1 inch = 4,000 feet
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PL-42
Delivery point to Valley Water
Milpitas
Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio TWA 1D - Hydraulic Model

Figure 5. Facility locations and pipeline alignments for Portfolio TWA 1d

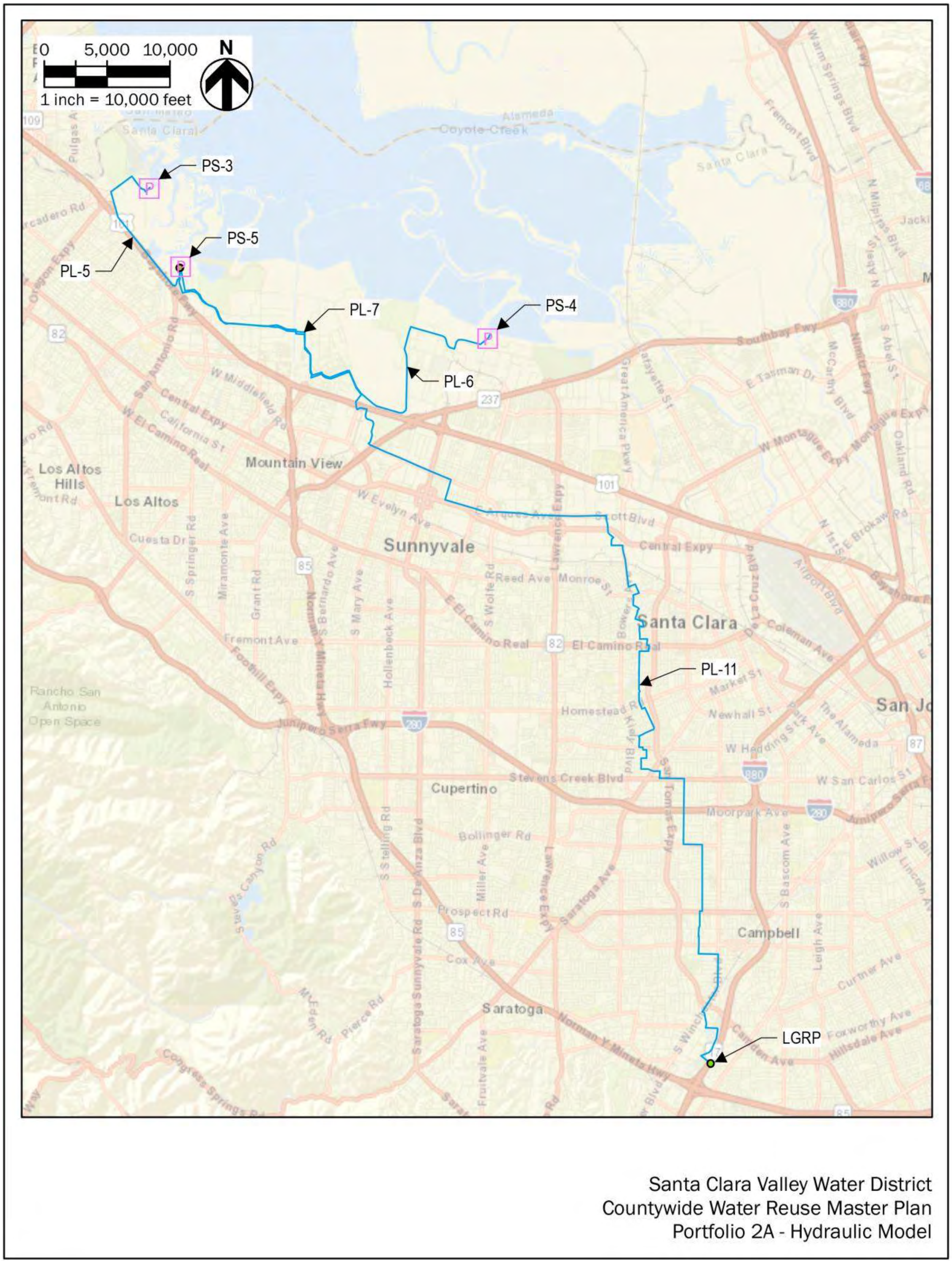
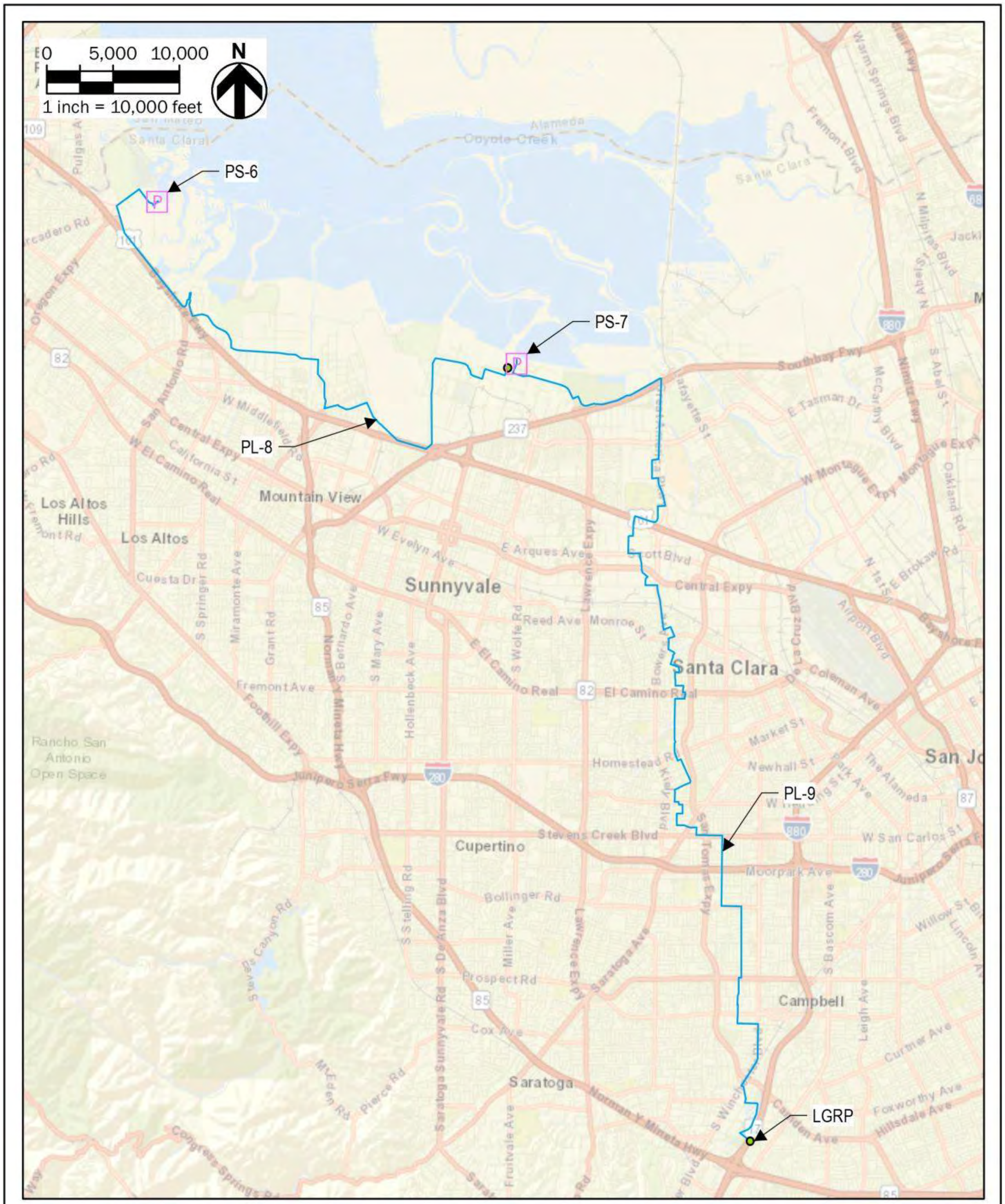
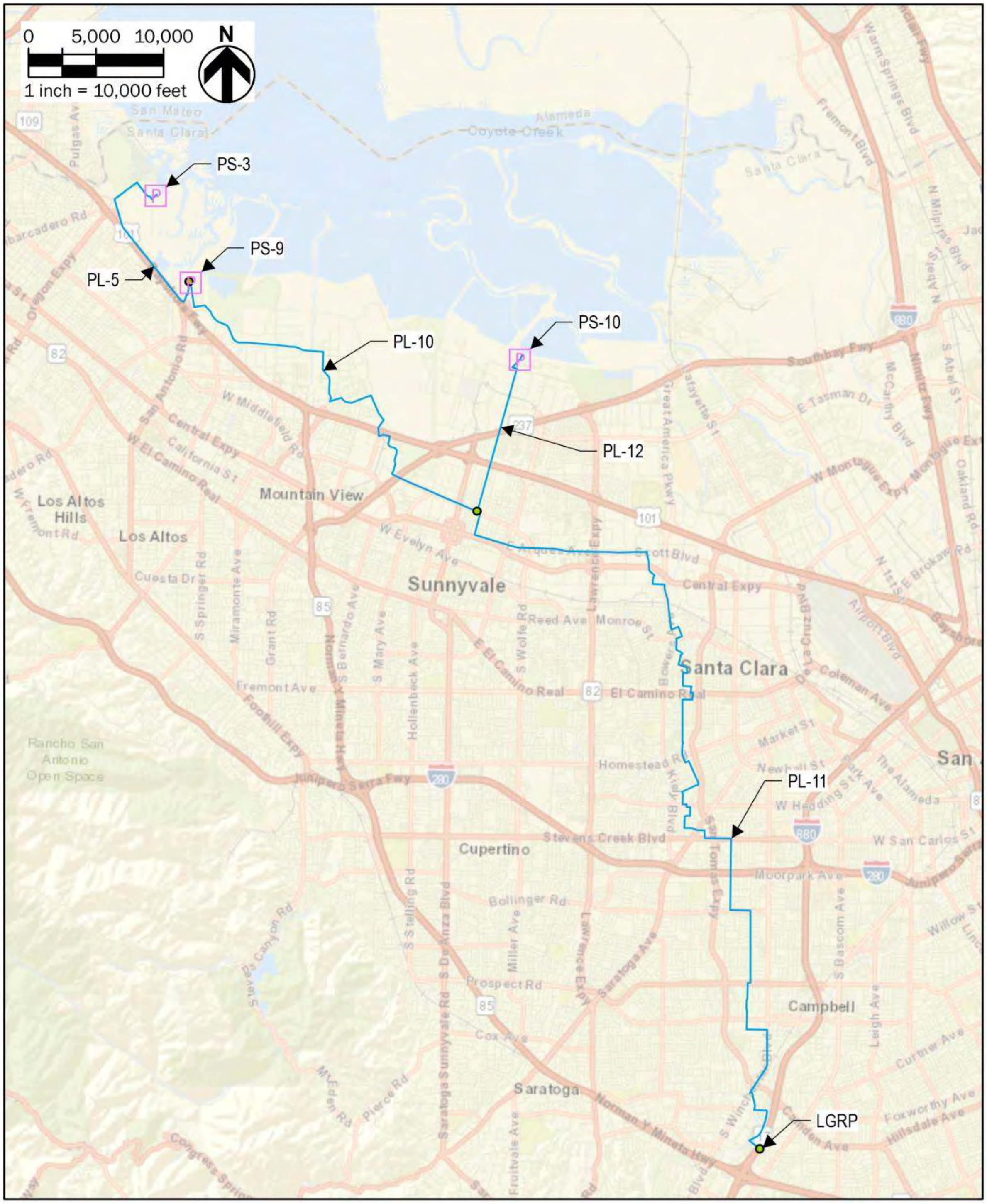


Figure 6. Facility locations and pipeline alignments for Portfolio 2a



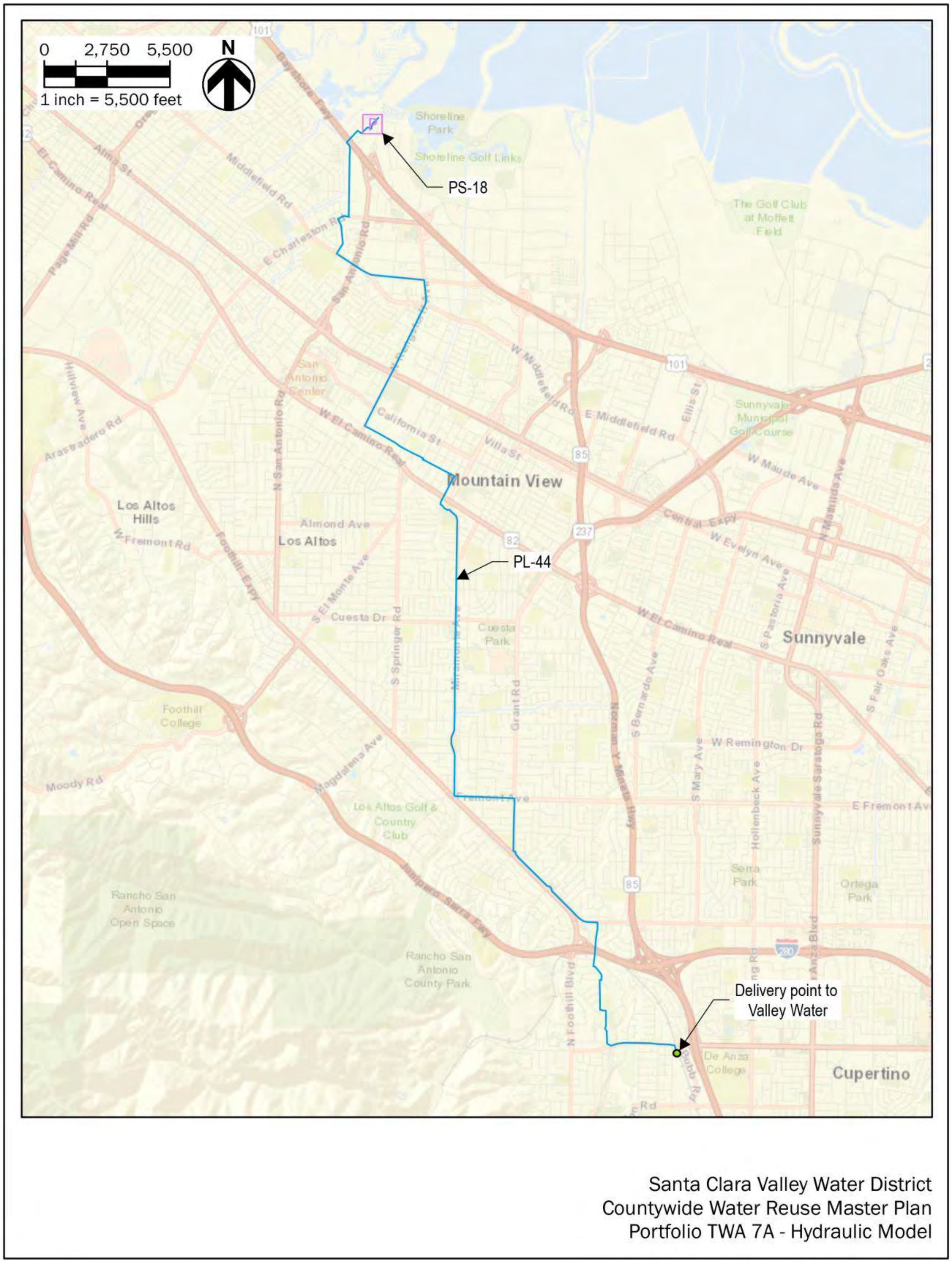
Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio 2B - Hydraulic Model

Figure 7. Facility locations and pipeline alignments for Portfolio 2b



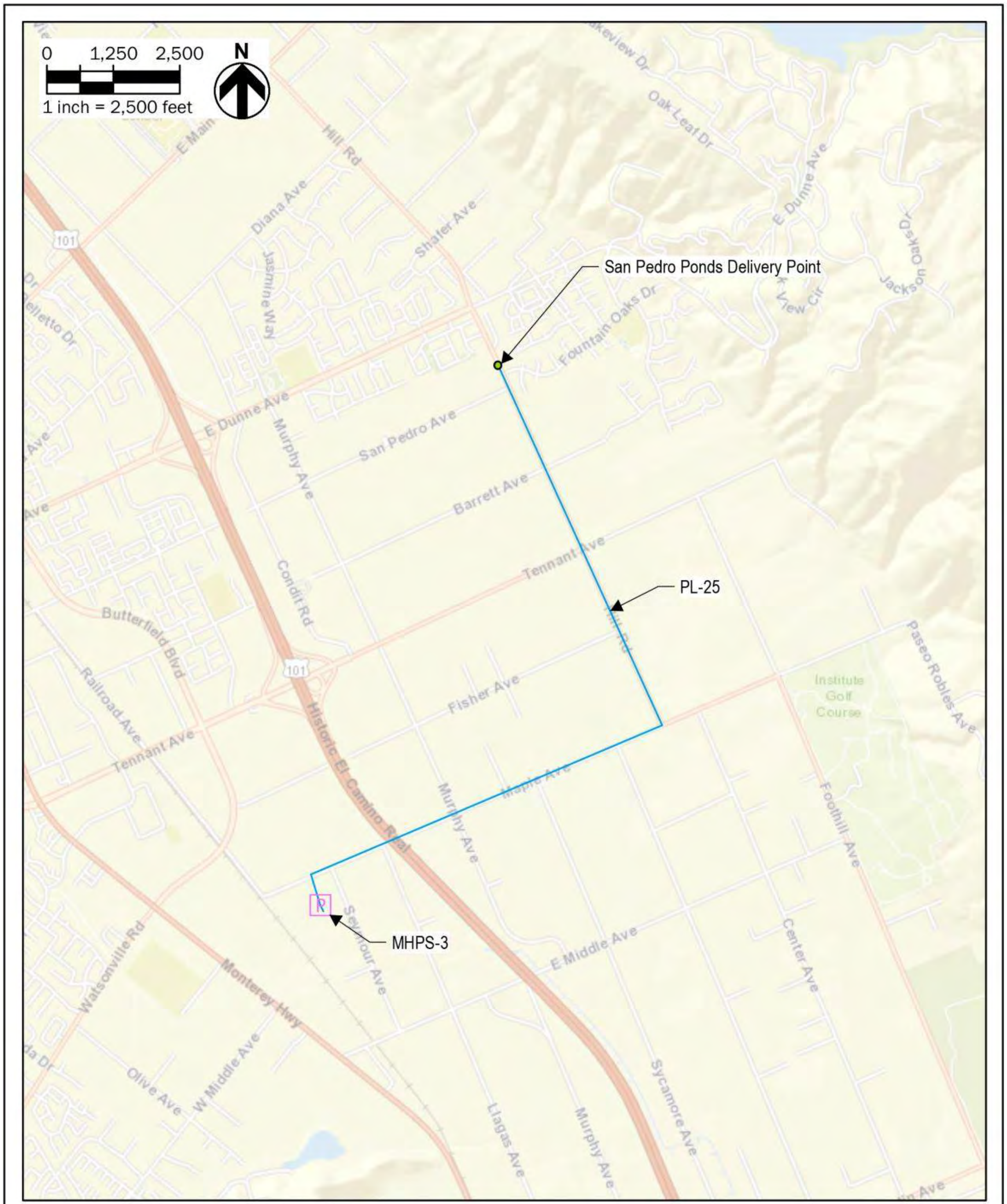
Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio 4 - Hydraulic Model

Figure 8. Facility locations and pipeline alignments for Portfolio 4



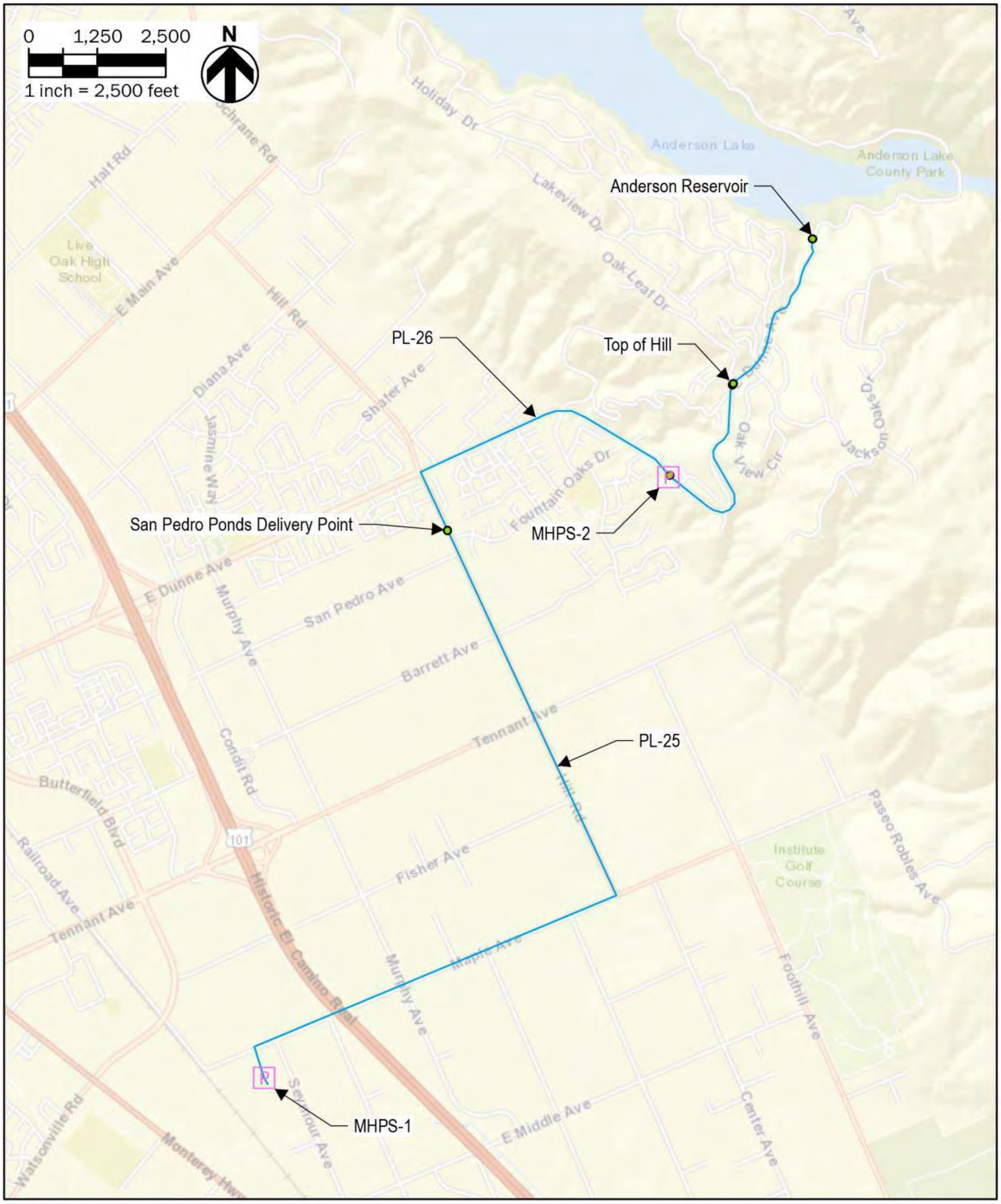
Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Portfolio TWA 7A - Hydraulic Model

Figure 9. Facility locations and pipeline alignments for Westside TWA (7a)



Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Morgan Hill Option 2 - Hydraulic Model

Figure 10. Facility locations and pipeline alignments for Morgan Hill Option 2



Santa Clara Valley Water District
Countywide Water Reuse Master Plan
Morgan Hill Option 3 - Hydraulic Model

Figure 11. Facility locations and pipeline alignments for Morgan Hill Option 3

Appendix C-2: SBWR System Master Plan Updates

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741 Allston Way
Berkeley, CA 94710

T: 510-540-7100

Prepared for: Valley Water

Project Title: Countywide Water Reuse Master Plan

Project No.: 4821 (Valley Water); 151772 (BC)

Contract No.: A4120A

Appendix C-2

Subject: South Bay Water Recycling (SBWR) System Master Plan Updates

Date: September 15, 2020 (reissued October 14, 2020)

To: Miguel Silva, Valley Water Project Manager

From: Jonathan Machorro, PE, HydroScience Engineers

Copy to: Jenny Gain, PE, Brown and Caldwell Project Manager

Prepared by: Jonathan Machorro, PE, HydroScience Engineers
California License: C83843

Curtis Lam, PE, HydroScience Engineers
California License: C59049

Reviewed by: Angela Singer, PE, HydroScience Engineers
California License: C70316

Table of Contents

List of Figures ii

List of Tables iii

Section 1: Introduction 1

Section 2: Market Assessment 2

- 2.1.1 SJMWS 2
- 2.1.2 City of Santa Clara 4
- 2.1.3 SJW 6
- 2.1.4 City of Milpitas 8
- 2.1.5 Market Assessment Summary 10

Section 3: Modeling Criteria 11

Section 4: Proposed Distribution System Upgrades 13

4.1 Pumping and Storage 13

- 4.1.1 TPS Upgrades 13
- 4.1.2 City of Santa Clara – Corporation Yard Tank and Pump Station 13
- 4.1.3 City of Santa Clara – Rabello Tank and Pump Station 14
- 4.1.4 Additional pumping and storage projects 14

4.2 Supplemental Water Supply Projects 19

- 4.2.1 SJMWS Wells #1 and #2 19
- 4.2.2 City of Santa Clara Well #32 19
- 4.2.3 SVAWPC Expansion 19

4.3 Pipeline Projects 20

- 4.3.1 North San Jose Improvements 20
- 4.3.2 North Santa Clara Improvements 20
- 4.3.3 City of Milpitas Improvements 21
- 4.3.4 SJW improvements 22

Section 5: Model Results 24

5.1 Near-Term NPR Additions 24

5.2 Available Capacity 25

5.3 Distribution System Storage 25

Attachment A: Project Location Maps and Model Results A-27

List of Figures

Figure 1. Irrigation Meters Proposed for Recycled Water Retrofit in SJMWS Northern Service Area 3

Figure 2. Locations of Pending Recycled Water Projects in Santa Clara's Service Area 5

Figure 3. San Jose Water – Proposed Recycled Water Alignments 7
Figure 4. Milpitas Recycled Water Distribution System Expansion 9
Figure 5. Yerba Buena Storage Tank Site Plan from SBWR Strategic and Master Plan 16
Figure 6. Zone 2 Distribution System Modifications Associated with Yerba Buena Storage Tank 17
Figure 7. Mabury Tank and Pump Station Conceptual Layout (SJW, 2017) 18
Figure 8. Proposed Santa Clara Pipeline Infrastructure Projects 21
Figure 9. Proposed City of Milpitas Pipeline Infrastructure Projects 22
Figure 10. Proposed San Jose Water Company Pipeline Infrastructure Projects 23

List of Tables

Table 1. SBWR Existing and Buildout Recycled Water Demands 2
Table 2. SJMWS Existing and Buildout Recycled Water Demands 3
Table 3. Santa Clara’s Existing and Buildout Recycled Water Demands 4
Table 4. SJW Existing and Buildout Recycled Water Demands 6
Table 5. Milpitas’s Existing and Buildout Recycled Water Demands 8
Table 6. Recycled Water Demands by Pressure Zone 10
Table 7. SBWR Hydraulic Model Peaking Factors 11
Table 8. SBWR Storage Requirements – Existing and Buildout 26

Section 1: Introduction

This technical memorandum (TM) summarizes updates to the South Bay Water Recycling (SBWR) System Master Plan completed as part of Valley Water's (VW) development of the Countywide Water Reuse Master Plan (CoRe Plan) in collaboration with SBWR retailers, which include:

- City of San José Municipal Water System (SJMWS)
- City of Santa Clara
- San Jose Water (SJW)
- City of Milpitas

In addition to summarizing updates incorporated into SBWR's hydraulic model, this TM also describes recycled water (non-potable reuse [NPR]) demands and hydraulic modeling results for existing conditions and buildout (2040) scenario and includes several recommendations.

As described in ***Appendix C-1*** (Modeling Plan and Results), HydroScience Engineers (HydroScience) revised SBWR's hydraulic model to reflect updated existing conditions and the projected future buildout in terms of system demands and infrastructure. Buildout conditions represent SBWR retailers' anticipated 2040 demands and the infrastructure projects required to meet those demands. HydroScience identified and evaluated potential approaches for meeting 2040 demands based on design criteria identified in ***Appendix C-1*** and peaking factors built into the SBWR hydraulic model.

Section 2: Market Assessment

Existing SBWR demands were based on meter data provided by SBWR for the 2017 calendar year. Projected 2040 recycled water demands were provided by SBWR based on input from each of the four retailers. Table 1 presents both the existing (2017) demands and the projected (2040) recycled water demands.

Table 1. SBWR Existing and Buildout Recycled Water Demands

SBWR Retailer	Demands (acre-feet per year [AFY])		
	Existing (2017)	Incremental Increase (between 2017 and 2040)	Buildout Projection (2040)
SJMWS	5,124	4,376	9,500
Santa Clara	5,049	3,951	9,000
SJW	2,691	6,934	9,625
Milpitas	1,121	1,689	2,810
Total	13,985	16,950	30,935

The approach for applying the incremental increased recycled water demands within each SBWR retailer's service area is described for each retailer in the following subsections.

2.1.1 SJMWS

As summarized in Table 2, the SJMWS currently serves about 5,124 AFY of recycled water within the northern (north of Highway 101) and Edenvale service areas. At buildout, the SJMWS projected that additional recycled water demands would exclusively occur within their North San Jose service area. SJMWS stated that they expected no additional recycled water demand in their Edenvale service area.

The current 1,231 AFY recycled water demand in the northern SJMWS service area serves industrial (628 AFY) and irrigation (603 AFY) uses. SJWMS provided a map and summary of irrigation meter demands for customers within their North San Jose service area that could be connected to recycled water by 2040. A map showing the meter locations is included as Figure 1. The demand represented by these irrigation meters was estimated to be 1,060 AFY based on meter data provided by SJMWS. It was assumed that this entire irrigation demand could be retrofit to receive recycled water. Section 4 includes a conceptual project description to connect the demands identified by SJMWS to the SBWR distribution system.

After accounting for existing demand and the 1,060 AFY of demand that could be added by the retrofit of these meters, an additional 3,316 AFY of recycled water demand was required to be added to the SJMWS – North San Jose service area to meet the 2040 buildout recycled water demands. In the absence of specific projects that would meet this demand, a decision was made to scale up all existing recycled water demands in the North San Jose service area were scaled up by a factor of 3.7, which equates to (3,316 + 1,221) / 1231. The scaled-up demands were located at the same coordinates where existing demands were delivered.

Table 2. SJMWS Existing and Buildout Recycled Water Demands

Service Area	Demands (AFY)			
	Existing (2017)	Incremental Increase (between 2017 and 2040)		Buildout Projection (2040)
		Identified (irrigation)	Scaled	
Northern	1,231	1,060	3,316	5,607
Edenvale	3,893	--	--	3,893
SJMWS Total	5,124	1,060	3,316	9,500

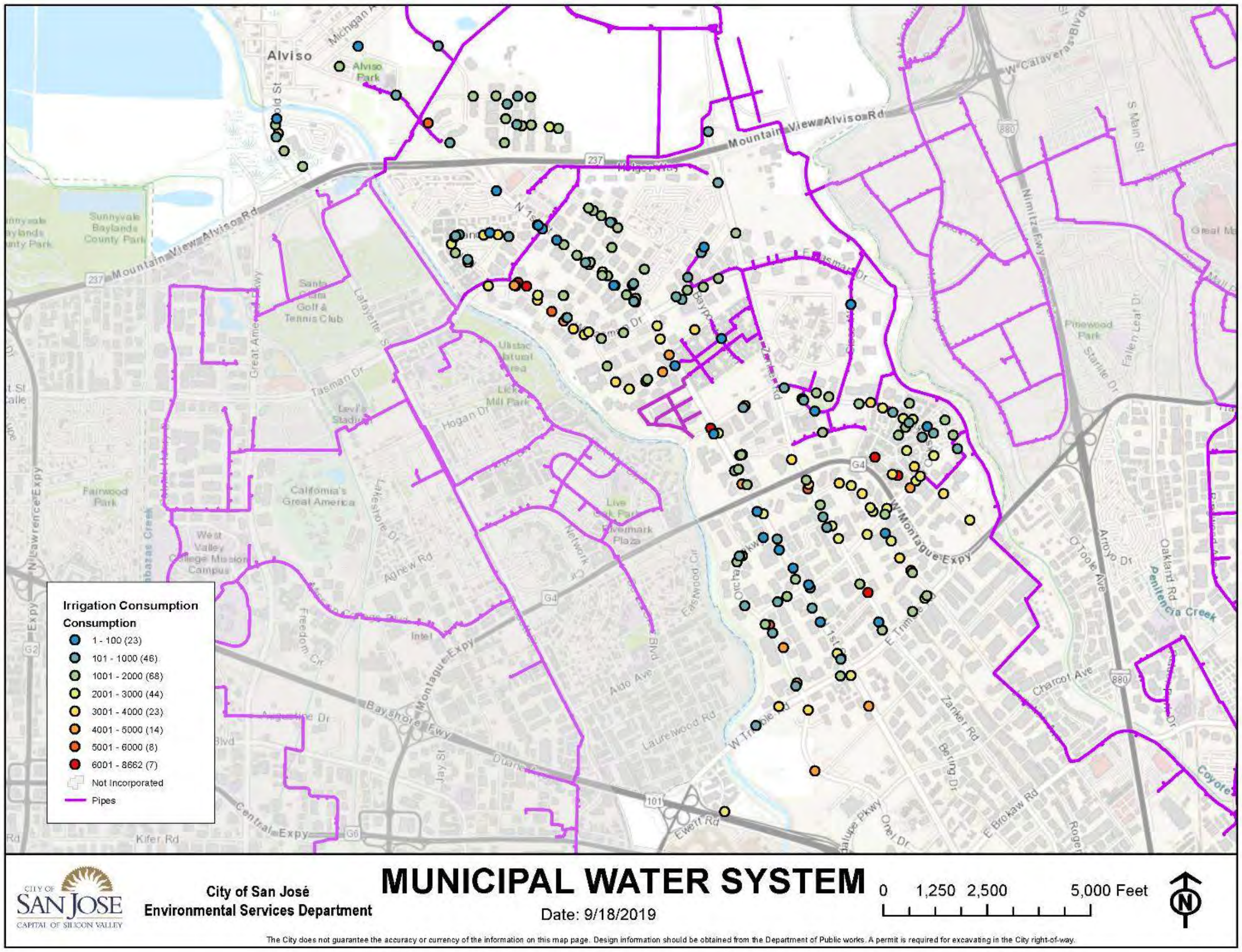


Figure 1. Irrigation Meters Proposed for Recycled Water Retrofit in SJMWS Northern Service Area

2.1.2 City of Santa Clara

The City of Santa Clara expects recycled water demand to increase the existing demand of about 5,050 AFY to 9,000 AFY in 2040, as shown in Table 3. Approximately 3,270 AFY of this recycled water demand is located north of Arques Drive in their SFPUC service area.

Lists of known future recycled water customers were provided to HydroScience by the City of Santa Clara. These customers had a combined demand of 1,638 AFY, of which 811 AFY were pending City approval. Pending projects were identified as having submitted recycled water demand estimates to the City for approval. Santa Clara characterized the remaining projected demand (827 AFY) as being related to future projects that have not submitted formal requests. Of the specific customers identified by the City of Santa Clara, the majority of these additional demands would be for cooling tower makeup at industrial sites or data centers. The remainder of these demands are for customers proposed to use recycled water for irrigation or toilet/urinal flushing. The locations of these known future recycled water customers are shown in **Figure 2**.

After accounting for existing demands and known future recycled water customers, an additional 2,312 AFY of recycled water demand was needed to meet the City's buildout projection of 9,000 AFY in 2040. The City of Santa Clara expects this additional recycled water demand to be located in their SFPUC service area.

To achieve the desired buildout demand of 9,000 AFY, existing and proposed demands north of Highway 101 and near Arques Drive were scaled up by a factor of 1.7 from their existing values, which equates to (3,270 + 2,312) / 3,270. The scaled-up demands were located at the same coordinates where existing demands are located.

Table 3. City of Santa Clara Existing and Buildout Recycled Water Demands

Service Area	Demands (AFY)			
	Existing (2017)	Incremental Increase (between 2017 and 2040)		Buildout Projection (2040)
		Known Recycled Water Customers	Scaled Demands	
City of Santa Clara Total	5,050	1,638	2,312	9,000

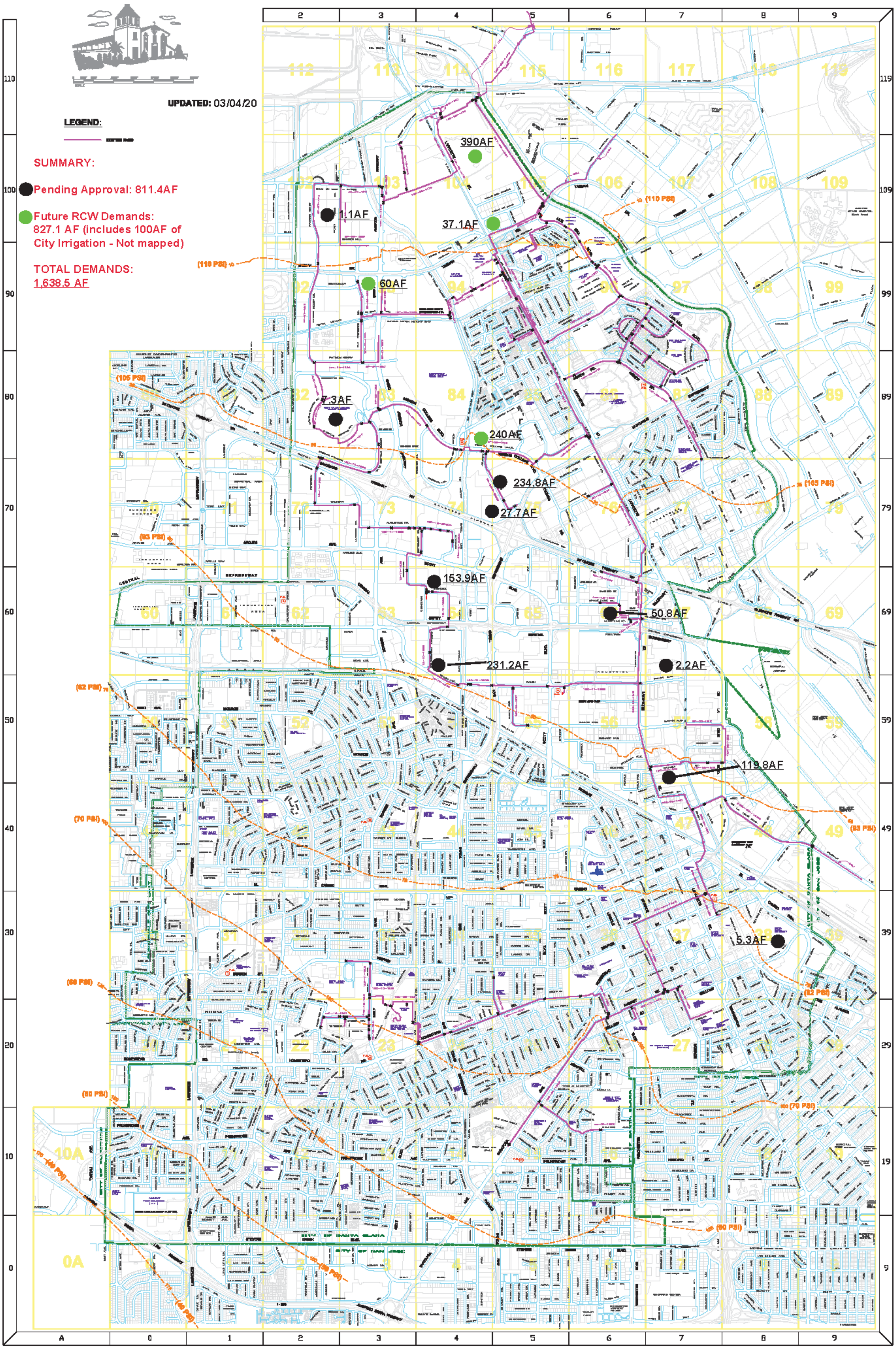


Figure 2. Locations of Pending Recycled Water Projects in Santa Clara's Service Area

2.1.3 SJW

The SJW service area contains pipelines owned, operated, and maintained by both SJW and SBWR. Since 2010, SJW has constructed approximately 27 miles of recycled water pipelines in its service area that it owns, operates, and maintains. SJW is allowed to own recycled water infrastructure in accordance with the execution of two Wholesaler Retailer Agreement Amendments that were executed between SJW and the City of San Jose, as well as approval of the California Public Utilities Commission (CPUC).

After constructing the new pipelines, SJW has been retrofitting customers to receive recycled water along pipelines it owns. SJW is currently adding customers along their recycled water pipelines, and has not fully realized the recycled water demand from these recently constructed projects. It was estimated that an additional 1,225 AFY of demand could be realized from the connection of customers along these alignments and along the system owned and operated by SBWR within the San Jose Water service area. To represent this demand in the hydraulic model, the existing San Jose Water demands were scaled up by a factor of 1.45, which is equivalent to (2,697 + 1,225) / 2,697.

Between now and 2040, SJW is planning to construct a number of additional recycled water pipelines. Identified as Alignments E, I, J, L, P, and Q in the SJW Recycled Water Master Plan, these projects represent an additional 5,703 AFY of recycled water demand. Planned NPR demands from these projects were located at specific nodes in the hydraulic model where a turnout between the SBWR distribution system and a future San Jose Water pipeline would be located. In order to construct these projects, SJW must execute additional Wholesaler Retailer Agreement Amendments with SBWR and obtain approval from the CPUC to construct the projects.

Figure 3 shows the map of all recycled water project alignments from the SJW Recycled Water Master Plan (SJW, 2010).

Table 4 summarizes the SJW existing and anticipated buildout (2040) demands.

Table 4. SJW Existing and Buildout Recycled Water Demands

Service Area	Demands (AFY)			
	Existing (2017)	Incremental Increase (between 2017 and 2040)		Buildout Projection (2040)
		Future SJW Projects	Customers on SJW Owned Pipelines	
SJW Total	2,697	5,703	1,225	9,625

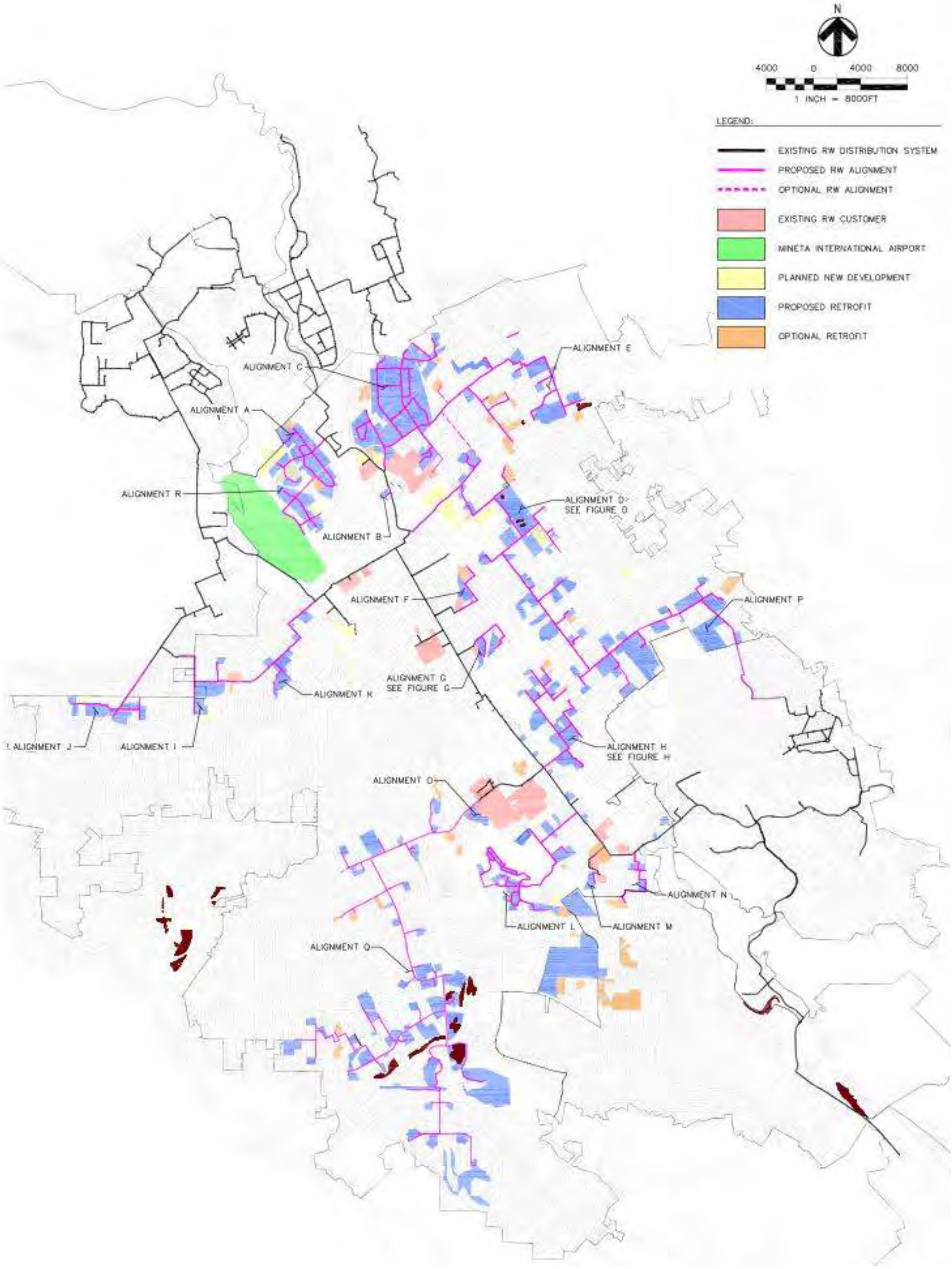


Figure 3. San Jose Water – Proposed Recycled Water Alignments

2.1.4 City of Milpitas

Existing City of Milpitas recycled water demands are approximately 1,121 AFY. Figure 4 shows how the City of Milpitas intends to add 1,689 AFY of demand by 2040. For the purpose of hydraulic modeling, the demand from this system expansion was located equally at three points of connection to the existing SBWR distribution system within Milpitas. Because recycled water demand projections were known for the City of Milpitas and existing demands were not expected to change, scaling of the City of Milpitas recycled water demands was not required.

Table 5 summarizes the City of Milpitas' existing and anticipated buildout (2040) demands.

Table 5. City of Milpitas Existing and Buildout Recycled Water Demands

Service Area	Demands (AFY)		
	Existing (2017)	Incremental Increase (between 2017 and 2040)	Buildout Projection (2040)
City of Milpitas Total	1,121	1,689	2,810

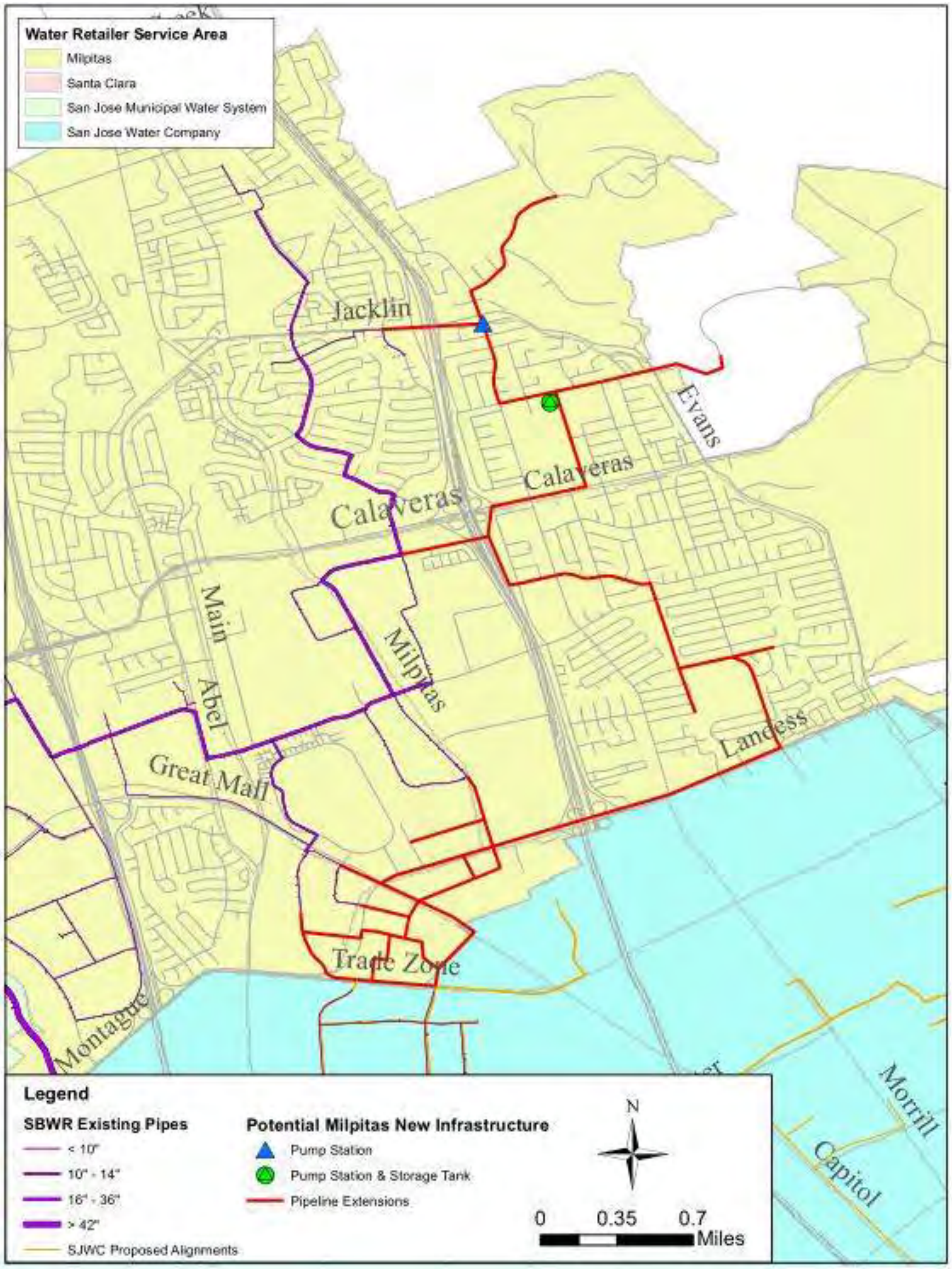


Figure 4. City of Milpitas Recycled Water Distribution System Expansion

2.1.5 Market Assessment Summary

Table presents the existing and buildout demands by SBWR pressure zone.

Table 6. Recycled Water Demands by Pressure Zone

SBWR Pressure Zone	Existing Demand – 2017 (mgd)			Buildout Projection – 2040 (mgd)		
	Average Day	Maximum Day	Peak Hour	Average Day	Maximum Day	Peak Hour
1	8.0	11.5	21.4	19.0	27.9	52.2
2	1.1	1.8	5.1	4.3	7.0	19.7
3	3.4	4.5	5.3	4.3	5.9	7.0
Total	12.5	17.8	--	27.6	40.8	--

It is noted that peak hour demands are not additive, as the peak hour occurs at different times in different zones. Within each zone, the peak hour demand occurs at 10:00 pm (Zone 1), 11:00 pm (Zone 2) and 5:00 am (Zone 3). This is true for both existing and buildout scenarios, since both scenarios had similar diurnal patterns. Additionally, the diurnal pattern of recycled water demand in each zone as well as the filling and draining of recycled water storage tanks impacts the timing when recycled water is required in a specific zone. During existing conditions, the TPS had a maximum peak hour delivery flow of approximately 26.2 MGD, which happened to occur at 7:00 am. It is believed that this is due to the tank fill needs and diurnal patterns in Zone 1.

It is also noted that SBWR currently has no system storage in Zone 1, 4 MG in Zone 2, and 5.5 MG in Zone 3. Without system storage in Zone 1, demands in Zone 1 are satisfied exclusively by the Transmission Pump Station (TPS). Storage in Zones 2 or 3 do not benefit Zone 1, as the demands in Zones 2 and 3 are high enough to require recycled water to exclusively travel from north to south during all scenarios.

Section 3: Modeling Criteria

To model the existing conditions and buildout scenario in SBWR's distribution system, HydroScience used Infowater (software by Innovyze) and relied upon modeling criteria summarized as follows.

Water supply sources: This modeling effort focuses on evaluating the distribution system and consider one combined stream from the RWF and SVAWPC (i.e., without separately evaluating flows from the two separate facilities).

Demands: All existing demands are per actual data provided by the retailer and SBWR. Buildout demand projections are detailed in Section 2.

Demands and peaking factors: Based on the diurnal patterns and seasonal variation in water use from data provided by the City, peak month, peak day, and peak hour values were calculated as detailed in Table 7. An evaluation of the SBWR's 2017 data from meters and pump station SCADA suggests diurnal and seasonal water use patterns that can be simplified into peaking factors. Peak day demands were identified based maximum daily demand in the dry season trends for three discrete end uses: irrigation, industrial, and agricultural uses.

During the 2018 model update, peaking factors and diurnal curves were calculated from SBWR 2017 meter data and SCADA pump station data. Peak day demands were identified as the maximum daily demand during the dry period. The peak day demand factors were discretized per use type and were incorporated into the model demands as such.

Table 7. SBWR Hydraulic Model Peaking Factors

Metric	End Use	Peaking Factor (PF)	Peak Demand Calculation
Peak Month Demand		1.5	= PF * Average Day Demand
Peak Day Demand	Irrigation	1.7	= PF * Max Day Demand
	Industrial	1.1	
	Agricultural	2.1	
Peak Hour Demand		1.4	= PF * Peak Day Demand

Water quality: No separate evaluation of water quality was conducted for this model. The original intent was to evaluate differences in TDS between different recycled water sources. With only one recycled water source in the SBWR system, due to the desire by SBWR to not interconnect the SBWR system with other recycled water systems, no separate water quality analysis was required.

Even though the buildout model contains new sources of supply from groundwater wells, it is not expected that the groundwater wells will cause a water quality issue of concern. Groundwater from these wells is expected to reduce the TDS concentration of the local recycled water supply and result in an overall benefit to recycled water quality.

At buildout, additional purified water from an expansion of the SVAWPC will be required to maintain the PDF target of 500 mg/L (plus or minus 50 mg/L.

Design criteria: The hydraulic model reflects the following design criteria for the existing and buildout conditions.

- A minimum of 60 psi dynamic pressure at each node in the SBWR distribution system.
- No maximum distribution system pressures

- A maximum pipeline velocity of 7 feet per second in pipelines.
- Provide pump station capacity with one duty pump as a standby

To meet the pump station capacity design criteria, HydroScience specifically interpreted this requirement for the SBWR pump stations as follows.

- At the TPS, add pumping capacity to maintain a maximum peak hour flow below 30,000 gpm with one duty pump off-line. Delivering 30,000 gpm requires an increase in the TPS firm capacity and confirmation that the RWF and SVAWPC can reliably produce that much effluent at any one time.
- Another objective was to assure that all pump stations do not operate with all station pumps on simultaneously. The firm capacity of any pump station is equivalent to the maximum capacity the pump station can deliver with its largest pump out of service. Jockey pumps or smaller pumps that do not typically operate during peak duty conditions are also assumed to be offline during peak hour flow conditions, consistent with the original design of the pump station and how the RWF operates the facility.

Pump station control strategies: Significant coordination efforts were employed to update the control strategies in the SBWR hydraulic model to reflect how RWF staff operate the SBWR distribution system. This resulted in the elimination of timers, which were used in previous versions of the model to regulate pump station deliveries. HydroScience implemented flow and pressure-based pumping strategies, and a more accurate regulation of pressure delivered by this infrastructure. All systems that are represented in the model reflect actual control strategies provided to the Consultant by the City. The only deviation from this strategy that was employed for hydraulic modeling purposes was the use of a pressure regulating valve (PRV) at the TPS. Though this PRV does not exist, in the absence of an alternate solution and at the recommendation of Innovyze, HydroScience included a PRV in the hydraulic model in order to more accurately reflects actual TPS delivery pressures.

For model calibration, RWF staff provided flow and pressure data for the 2018 and 2019 calendar years, control strategies, and anecdotal information to calibrate the model. Diurnal patterns were created for irrigation and industrial customers based on a combination of previous studies, information collected from specific AMI meter data collected by SBWR, and actual deliveries by the TPS. In general, all data used for model calibration was from the 2018 and 2019 calendar years.

Section 4: Proposed Distribution System Upgrades

This section describes the upgrades proposed for the SBWR distribution system infrastructure to accommodate the buildout recycled water demands identified in Section 2 and to continue operating SBWR distribution system in accordance with the modeling criteria outlined in Section 3.

The types of projects include pumping and storage, supplemental water supply, and pipeline projects. These are projects required for reliability and to address hydraulic deficiencies, and do not include the distribution system projects already specified in Section 2.3.1 of Appendix A-1. The buildout of the SBWR projects specified in that section will require the distribution system upgrade projects specified below.

The projects are sorted by type and are described in the sections below.

4.1 Pumping and Storage

Various pumping and storage projects are required to deliver the buildout SBWR demand, as summarized below. Attachment A presents map showing the location of each project.

4.1.1 TPS Upgrades

This project is an expansion of Project P6 in the SBWR Strategic and Master Plan with the exception that two 14.7 MGD pumps (1,000 hp) would be added at the TPS rather than one pump. This project would result in increased capacity at the TPS, enabling it to reliably deliver flows with one of the 1,000 hp pumps out of service. It is understood that there are existing bays at the TPS that can facilitate the installation of two new vertical turbine pumps of this capacity.

As part of the project, the power and long-term hydraulic performance of the TPS clearwell and condition of the existing pumps should be evaluated in parallel with the new pump installation.

The SBWR Strategic and Master Plan estimated that this cost would be approximately $1-$3M (December 2014 dollars) for one additional 1,000 hp pump. It was assumed that the addition of two pumps would be approximately an $8M project.

The addition of the new tanks, pump stations, and supplemental water supplies discussed elsewhere in this section is intended to cap peak hour TPS flows to approximately 30,000 gpm at buildout. Distribution system pump stations and supplemental water supplies would provide additional capacity during peak demand periods. During off-peak periods, distribution system storage tanks would be filled from the TPS, and supplemental water supplies would be allowed to recover.

4.1.2 City of Santa Clara – Corporation Yard Tank and Pump Station

This project includes construction of a 4 MG recycled water storage tank and 7,000 gpm recycled water pump station at the Santa Clara Corporation Yard site. The Santa Clara Corporation Yard is located at 1700 Walsh Avenue in the City of Santa Clara. The storage tank would be filled during off-peak hours through a new tank fill pipeline connecting the tank to the existing looped 24-inch SBWR pipeline on Lafayette Street. During the buildout model run, this pump station delivered approximately 3.2 MG during the peak day demand scenario. The Corporation Yard tank was sized to be able to fill and drain over the course of a day with a small factor of safety. At this volume, it is expected that the tank would either be welded steel or prestressed concrete. The tank would be constructed at grade.

The new Corporation Yard Pump Station would draw supply from the tank during peak hour at rates of up to 7,000 gpm. The pump discharge would be a 30-inch pipeline connecting to the 24-inch pipeline loop on Lafayette Street. The length of the tank fill and pump discharge lines are expected to be up to 2,000 LF each. Any flow delivered by the Corporation Yard Pump Station has the net effect of directly reducing flows required to be delivered by the TPS during peak hour.

Based on the unit costs per hp in ***Appendix A-5*** (Basis of Cost), a pump station horsepower of 570 hp, an assumed overall site development cost of approximately $2.50/gallon for the tank, and open trench construction for the tank fill and pump discharge pipelines, it is expected that the construction cost subtotal, with a 25% contingency, would be approximately $19.9M.

4.1.3 City of Santa Clara – Rabello Tank and Pump Station

This project would result in the construction of a 5 MG recycled water storage tank and 7,000 gpm recycled water pump station adjacent to the existing Rabello Sewer Pump Station. The Rabello site is located adjacent to Highway 237, Lafayette Street, and north of the PAL – BMX track. A large development, City Place, is in the planning phase and will repurpose the City of Santa Clara PAL – BMX track in the future.

Nearby portions of the SBWR distribution system include 12- and 16-inch pipelines that front the southern border of the Rabello Site on Lafayette Street and continue along the Guadalupe River. These pipelines, along with additional pipelines to increase conveyance capacity around Rabello, would fill the Rabello Tank and deliver water from the Rabello Pump Station.

During the buildout model run, this pump station delivered approximately 3.85 MG during the peak day demand scenario. In order to fully realize the 7,000 gpm of capacity at the Rabello Pump Station, distribution system improvements around Rabello are required. The Rabello Tank was sized to fill and drain over the course of a day with a small factor of safety. At this volume, it is expected that the tank would either be welded steel or prestressed concrete. The tank would be constructed at grade.

The new pump station would pump out of the tank during peak hour conditions at pumping rates of up to 7,000 gpm. The connected horsepower of the Rabello Pump Station would be approximately 675 hp. The pump discharge line would be a looped 16-inch pipeline that fronts the Rabello site. Any flow delivered by the Rabello Pump Station has the net effect of directly reducing flows required from TPS during peak hour.

Based on the unit costs per hp in ***Appendix A-5***, and an assumed overall site development cost of approximately $2,50/gallon for the tank, and open trench construction for the tank fill and pump discharge pipelines, it is expected that the construction cost subtotal, with a 25% contingency, would be approximately $19M. This cost estimate does not include nearby hydraulic improvements discussed in Section 4.3.

4.1.4 Additional pumping and storage projects

Based on direction from SBWR, this document limited any modeling of SBWR pumping and storage projects to those located in City of Santa Clara. However, constructing additional storage and pumping projects in other areas also can provide benefit to the SBWR distribution system.

HydroScience identified two additional pumping and storage projects within other retailer service areas that would provide similar hydraulic benefits to the SBWR distribution system that merit further consideration, should the ability to construct pumping and storage projects outside of Santa Clara be reconsidered by SBWR. These projects include:

Yerba Buena Storage Tank, Pump Station 11 Modifications, and Zone 2 Reconfiguration. This project was identified as Project D9 in the SBWR Strategic and Master Plan. Maps showing the improvements are provided in Figures 4-7 and 4-6 from the SBWR Strategic and Master Plan, which we have labeled as Figures 5 and 6.

This project would result in the construction of a new 4 MG storage tank at the hydraulic grade line elevation for Zone 1, upgrade of Pump Station 11 to draw from the new tank, and construction of a new Zone 2 transmission line to serve existing SBWR customers located between the intersection of Senter Road and Yerba Buena Road and the Yerba Buena Storage Tank. This project would also result in the construction of a bypass pipeline for Pump Station 5, which would reconfigure the boundary of SBWR Zone 1 and Zone 2.

As a result of these changes, the TPS would then pump directly to both Yerba Buena Storage Tanks. Pump Station 8 would pump out of the existing storage tank at Yerba Buena through the new Zone 2 distribution system. Pump Station 11 would pump out of one or both Yerba Buena Storage Tanks to Zone 3.

In the SBWR Strategic and Master Plan, the overall cost for this capital project was estimated to be approximately $40M (December 2014 dollars). This project would result in the retirement of Pump Station 5.

Mabury Tank and Pump Station. SJW's San Jose Phase III Recycled Water Project includes construction of a 6 MG recycled water storage tank, new wells, and a recycled water pump station at the SJW Mabury Well Field Station, which is located near Mabury Road and N. King Road. This site plan is shown as Figure 7. A 24-inch recycled water pipeline constructed as part of Alignment D would provide the supply to fill the tank and receive flow from the pump station.

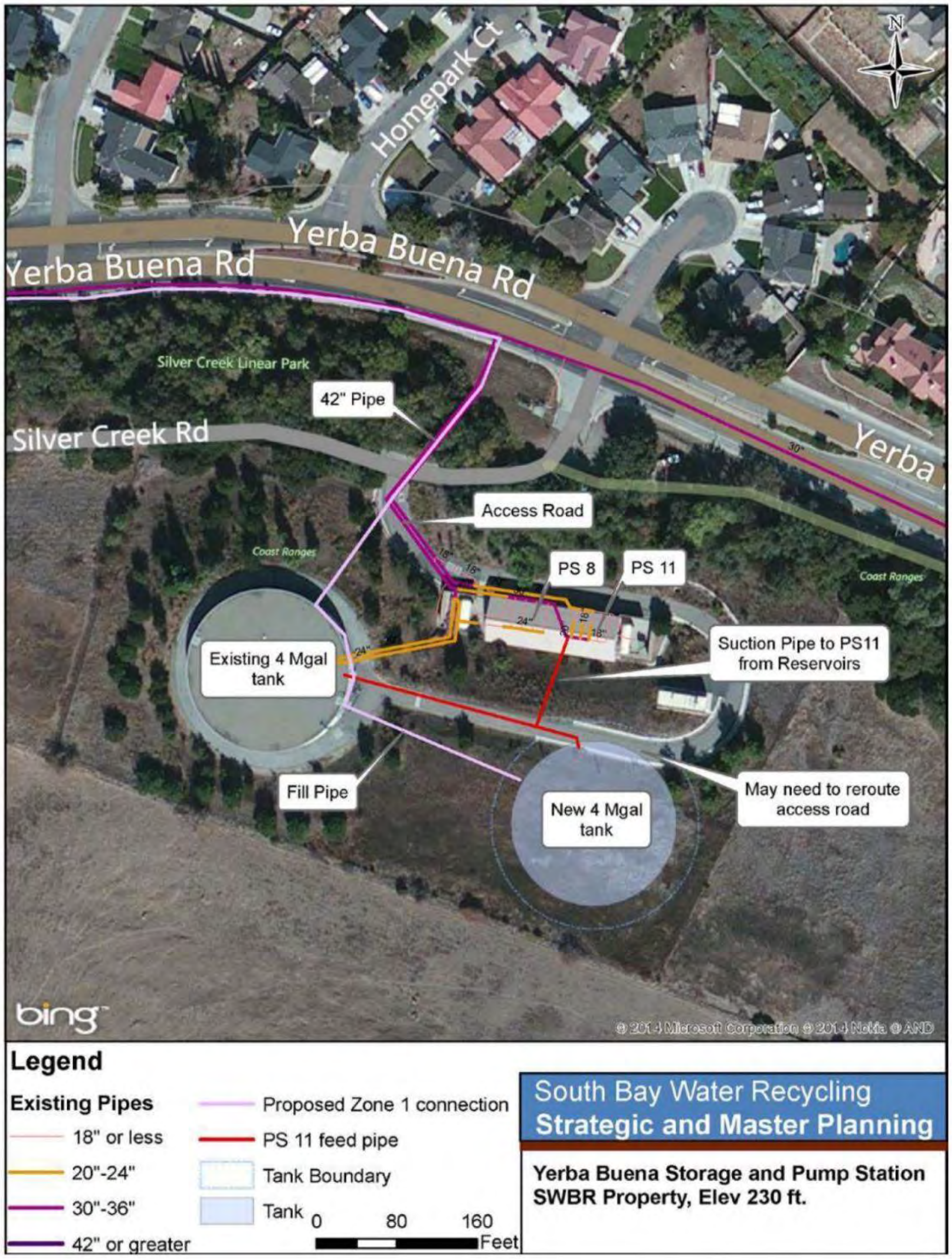
The project location is well suited to provide benefit to the SBWR distribution system due to its proximity to the 42-inch SBWR transmission pipeline. Similar to the other proposed pump stations, all delivered flow from the Mabury Pump Station during peak hour has the net effect of reducing TPS peak hour flow rates. Implementation of this project stalled during the CEQA permitting phase because capital project expansion was halted by SBWR.

This project was intended to support the continued implementation of SJW's recycled water improvements within its service area. Originally, this project was proposed as part of a series of recycled water expansion projects associated with the execution of Wholesaler Retailer Agreement Amendment #3 between SBWR and SJW. SJW had proposed to pay for the entire cost for this project in exchange for providing capacity to allow SJW to construct other recycled water pipeline projects within its service area at its own cost. Additionally, the Mabury Tank and Pump Station would be used to help provide source water to pump to Alignment E, a planned expansion of the SBWR distribution system that would be constructed by SJW. Without this project, it is not expected that SJW will be able to fully realize its buildout 2040 recycled water demands.

No separate cost estimate was prepared for this project, since it would not result in any capital cost outlays or result in capacity fee credits that could be used to fund other SBWR reliability improvements. Additionally, SJW does not typically publically announce any capital costs for its infrastructure.

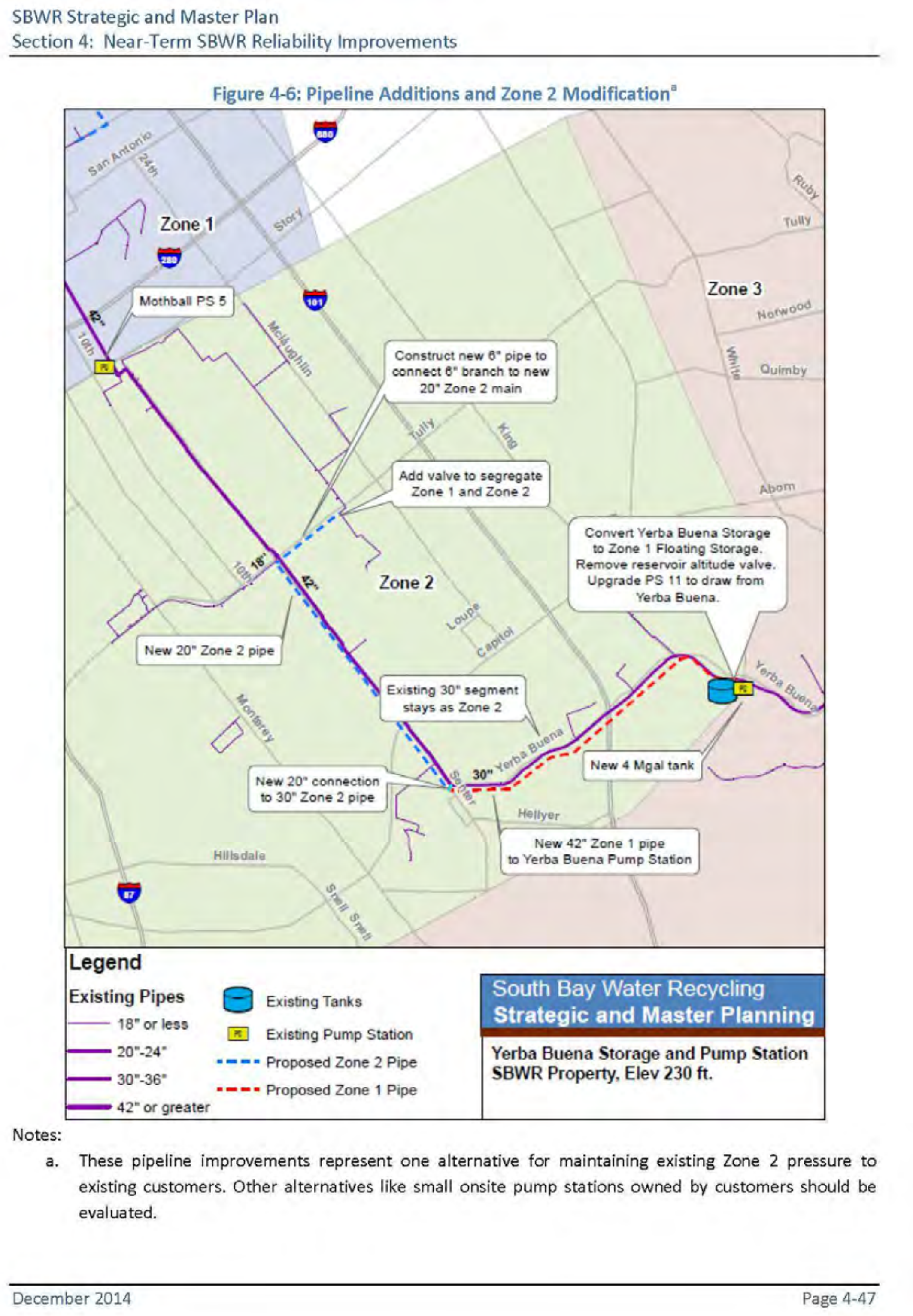
SBWR Strategic and Master Plan
Section 4: Near-Term SBWR Reliability Improvements

Figure 4-7: Overview of Yerba Buena Site



December 2014
Page 4-48

Figure 5. Yerba Buena Storage Tank Site Plan from SBWR Strategic and Master Plan



SBWR Strategic and Master Plan
Section 4: Near-Term SBWR Reliability Improvements

Figure 4-6: Pipeline Additions and Zone 2 Modification[a]

Mothball PS 5

Construct new 6" pipe to connect 6" branch to new 20" Zone 2 main

Add valve to segregate Zone 1 and Zone 2

Convert Yerba Buena Storage to Zone 1 Floating Storage. Remove reservoir altitude valve. Upgrade PS 11 to draw from Yerba Buena.

New 20" Zone 2 pipe

Existing 30" segment stays as Zone 2

New 4 Mgal tank

New 20" connection to 30" Zone 2 pipe

New 42" Zone 1 pipe to Yerba Buena Pump Station

Legend

Existing Pipes

18" or less	Existing Tanks
20"-24"	PS Existing Pump Station
30"-36"	Proposed Zone 2 Pipe
42" or greater	Proposed Zone 1 Pipe

South Bay Water Recycling
Strategic and Master Planning

Yerba Buena Storage and Pump Station
SBWR Property, Elev 230 ft.

Notes:

a. These pipeline improvements represent one alternative for maintaining existing Zone 2 pressure to existing customers. Other alternatives like small onsite pump stations owned by customers should be evaluated.

December 2014 Page 4-47

Figure 6. Zone 2 Distribution System Modifications Associated with Yerba Buena Storage Tank

Mabury Well Station Proposed Layout (6 MG Tank)

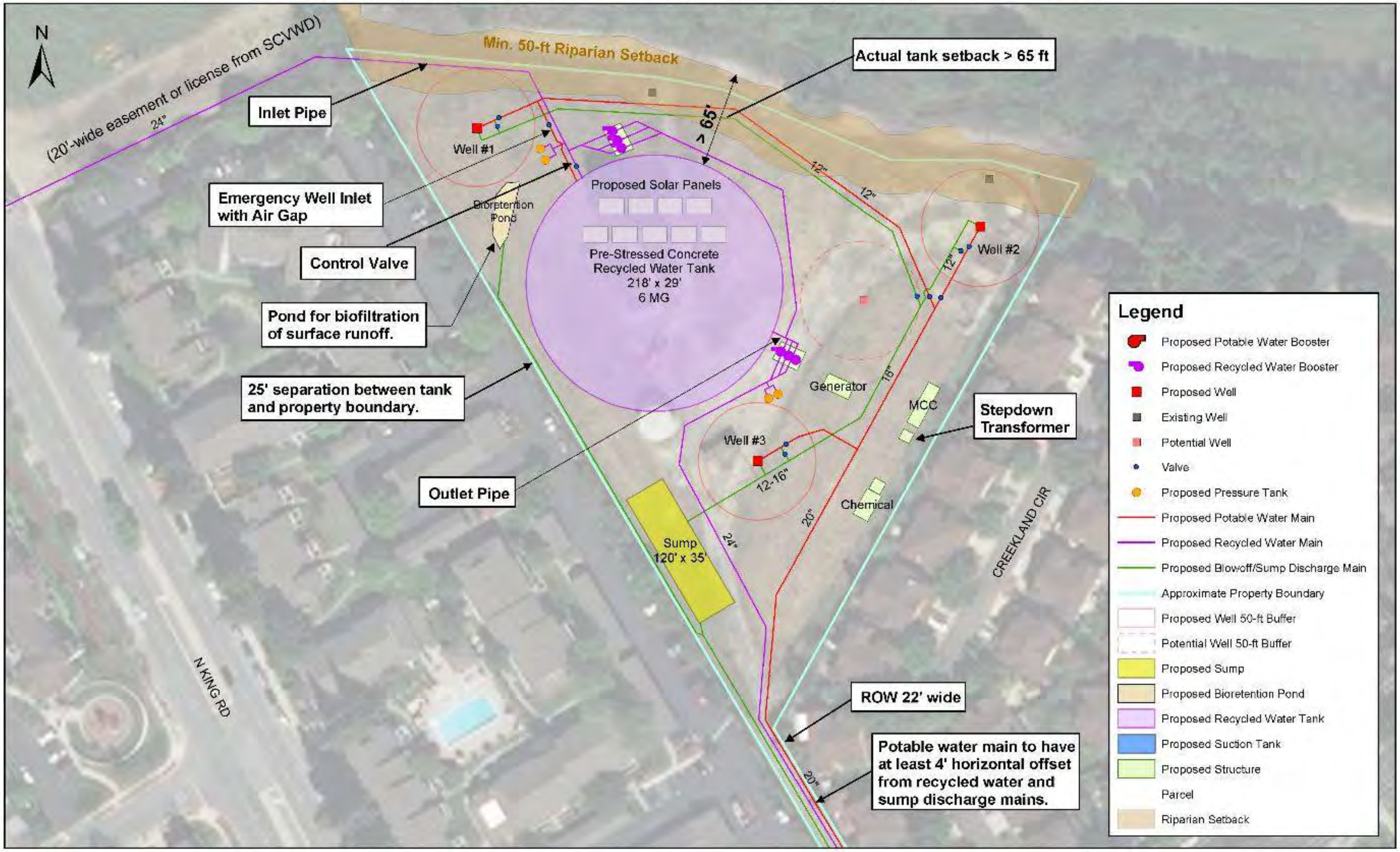

N
(20'-wide easement or license from SCVWD)
24"
Min. 50-ft Riparian Setback
Inlet Pipe
Actual tank setback > 65 ft
> 65'
Well #1
Emergency Well Inlet with Air Gap
Control Valve
Bioretention Pond
Proposed Solar Panels
Pre-Stressed Concrete Recycled Water Tank 218' x 29' 6 MG
Pond for biofiltration of surface runoff.
12"
12"
12"
Well #2
16"
25' separation between tank and property boundary.
Generator
MCC
Stepdown Transformer
Well #3
12-16"
Outlet Pipe
Chemical
Sump 120' x 35'
24"
20"
CREEKLAND CIR
N KING RD
ROW 22' wide
20"
Potable water main to have at least 4' horizontal offset from recycled water and sump discharge mains.
Legend
Proposed Potable Water Booster
Proposed Recycled Water Booster
Proposed Well
Existing Well
Potential Well
Valve
Proposed Pressure Tank
Proposed Potable Water Main
Proposed Recycled Water Main
Proposed Blowoff/Sump Discharge Main
Approximate Property Boundary
Proposed Well 50-ft Buffer
Potential Well 50-ft Buffer
Proposed Sump
Proposed Bioretention Pond
Proposed Recycled Water Tank
Proposed Suction Tank
Proposed Structure
Parcel
Riparian Setback

Figure 7. Mabury Tank and Pump Station Conceptual Layout (SJW, 2017)

4.2 Supplemental Water Supply Projects

Two supplemental water supply projects were identified to supplement the SBWR distribution system during peak hour. One additional project was identified to maintain SBWR recycled water quality near its TDS target of 500 mg/L. Each of these projects is further discussed in the sections below.

4.2.1 SJMWS Wells #1 and #2

Wells #1 and #2 are located next to Coyote Creek near River Oaks parkway in the SJMWS services area, adjacent to the Crescendo and Millbrook apartment communities. According to the SJMWS Draft Water System Master Plan, these existing groundwater wells have elevated levels of iron and manganese, which can cause aesthetic issues. Thus, these wells are currently unpermitted for domestic use. However, iron and manganese are not issues of concern for non-potable use, making these wells suitable and appropriate for use as a supplemental water supply for the SBWR distribution system. Groundwater quality from these wells is expected to meet or exceed the NPR+ water quality in the SBWR pipeline.

Both of these wells were assumed to pump groundwater into the SBWR distribution system at a rate of 1,493 gpm for a 12-hour period during buildout peak day demand conditions. To convey flow to the SBWR distribution system, a 12-inch pipeline with a length of up to 3,000 LF would be required to connect the wells to the SBWR transmission pipeline on Seely Avenue.

Supplying groundwater from these wells to the SBWR distribution system has the direct effect of reducing TPS deliveries. The timing of deliveries from the wells can vary based on actual conditions. For the purpose of this evaluation, we limited the number of hours the well could operate to 12 hours to allow the water levels in the groundwater basin to recover over the course of a day.

4.2.2 City of Santa Clara Well #32

Well No. 32 is located at Agnew Road and Lafayette Street within a Silicon Valley Power Station, as shown in Attachment A. The well pedestal and slab are in excellent condition, and the well is consistent with DDW construction guidelines. The well head is also equipped with a casing drain to allow dewatering in artesian conditions.

Similar to the SJWMS, the City has reported higher iron and manganese concentrations in Well #32 that make the groundwater unpermitted for domestic use but appropriate for non-potable use. The well is located adjacent to the 24-inch SBWR distribution pipeline on Lafayette Street in Santa Clara. To convey flow to the SBWR distribution system, a 200 ft 8-inch pipeline between Well #32 and the 24-inch pipeline in Lafayette Street is required.

This well would pump groundwater into the SBWR distribution system at a rate of 950 gpm for a 12-hour period during buildout peak day conditions. Supplying groundwater from these wells to the SBWR distribution system has the direct effect of reducing TPS deliveries. The timing of deliveries from the wells can vary based on actual conditions. For the purpose of this evaluation, we limited the number of hours the well could operate to 12 hours to allow the water levels in the groundwater basin to recover over the course of a day.

4.2.3 SVAWPC Expansion

Though the SVAWPC was not modeled in the distribution system, expansion of the SVAWPC is required at buildout to keep the TDS concentration of NPR+ recycled water to its original target of 500 mg/L.

Currently, the SVAWPC delivers purified water in increments of approximately 2.7 mgd depending on the water quality and flows in the SBWR distribution system. As flows increase, and assuming TDS concentrations from the RWF remain constant, additional purified water supplies will be required for SBWR to continue to deliver NPR+ recycled water at this quality.

No cost estimates to expand the capacity of the SVAWPC were developed for this TM. The 8 mgd SVAWPC cost approximately $72M to implement in 2014.

4.3 Pipeline Projects

A variety of pipeline improvement projects would be required to supply the buildout demands that were identified at the projected locations. A complete inventory of those demands follows below.

4.3.1 North San Jose Improvements

Though no project has been planned to expand demand in North San Jose, full connection of the customers identified in Figure 1 would be expected to require at least 10 miles of distribution pipelines. There would also be pipelines located within the North First Street and Zanker Road corridors, both of which have unique construction challenges.

The VTA light rail tracks are located on North First Street south of Tasman Drive. Crossing the light rail track requires trenchless construction methods and a permit from VTA.

Zanker Road contains up to five large diameter interceptors that convey sewage to the SJ/SC RWF. Finding a corridor in Zanker Road to construct an 8 to 12-inch pipeline could be challenging.

Additionally, depending on where additional, not yet identified demands are located, some pipelines may need to be extended, looped, or upsized to realize that buildout demand. Due to the uncertainty of where demands would be located, when they would be required, and the magnitude of those demands, no cost estimates were developed for those pipelines.

4.3.2 North Santa Clara Improvements

Within Santa Clara, pipeline improvements would be necessary to both fully realize the potential of the Rabello Pump Station and to accommodate additional demands within the northern portion of the Santa Clara SBWR distribution system. A map of these pipeline improvements is shown in Error! Reference source not found..

Currently, this portion of Santa Clara has a primary supply of recycled water from the 30-inch pipeline on Tasman. The 16-inch pipeline near Highway 237 is a secondary source of supply. When the Rabello Pump Station is operational at buildout, this new pump station becomes a primary supply to the City of Santa Clara. This additional pump station necessitates a variety of hydraulic improvements with the overall intent of increasing the hydraulic pumping capacity able to be pumped from Rabello. Pipeline improvements recommended by HydroScience to improve delivery capacity from Rabello include the following.

- Between Rabello and Lafayette Avenue: Upsize to 24-inch pipeline
- Lafayette Avenue between Great America Parkway and Tasman: New and upsized 24-inch pipeline. The City of Santa Clara indicated that portions of this pipeline may be constructed along the frontage of new developments on Lafayette. Cost sharing may be required to upsize this pipeline to 24 inches.
- Guadalupe River: Upsize from 12 to 16-inches.

The net effect of these changes provides Rabello with a 24-inch and two 16-inch pipelines to pump into, which is similar to the Corporation Yard and Mabury pump station options.

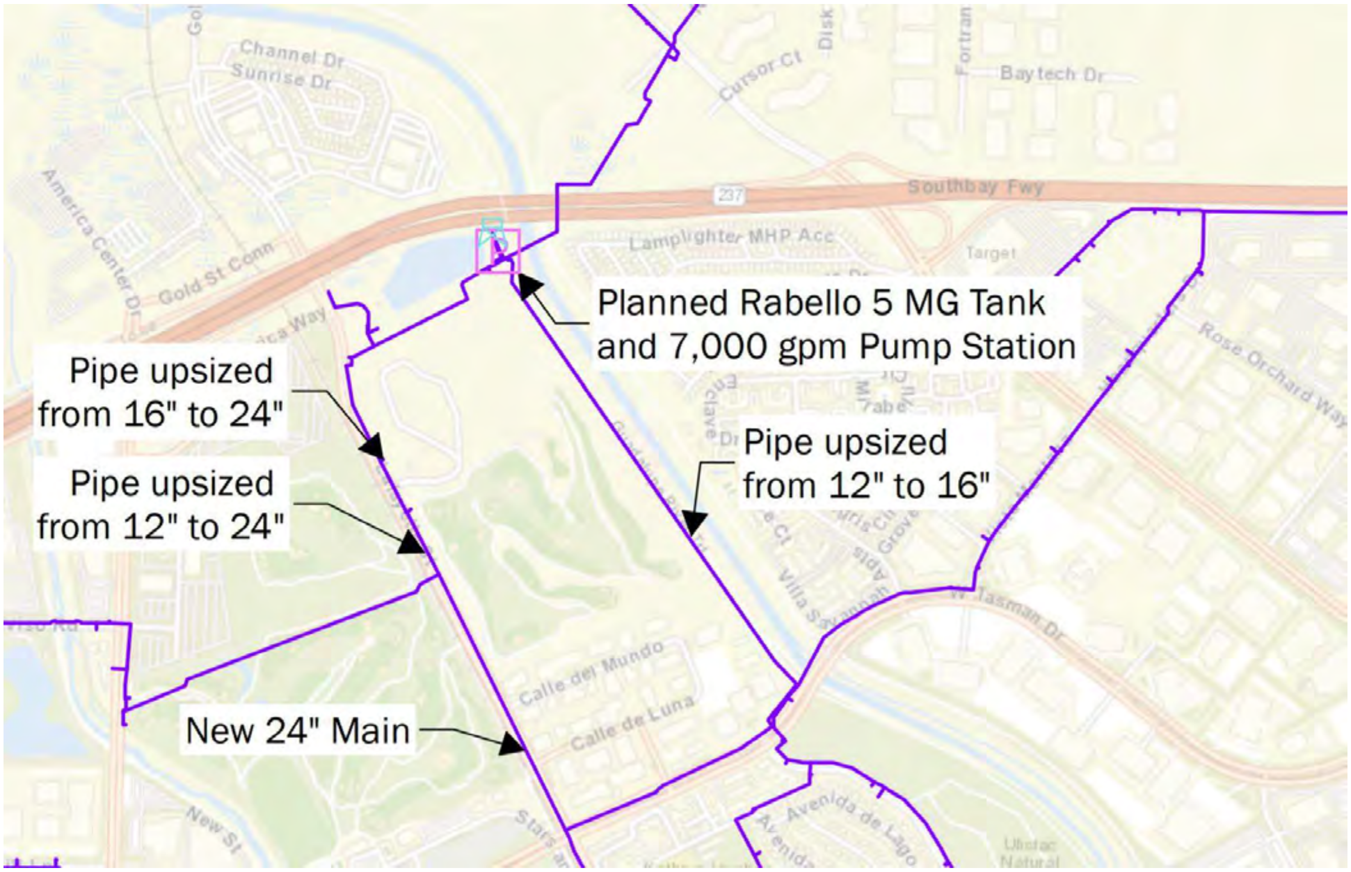


Figure 8. Proposed Santa Clara Pipeline Infrastructure Projects

4.3.3 City of Milpitas Improvements

Recycled water distribution system improvements are needed within the City of Milpitas service area to both increase deliveries and to increase reliability to areas between Curtis Avenue and to the east.

Reliability: The Town Center area of Milpitas is only supplied by one pipeline crossing the BART tracks at Curtis Avenue. If there was an outage on Curtis Street, the customers within the Town Center would not have any secondary sources of supply and would not have recycled water.

One option to increase reliability would be to connect the recycled water distribution systems in the SJW and the City of Milpitas service areas. On Trade Zone Avenue near Ringwood Avenue, there are 8-inch recycled water distribution systems serving customers in the City of Milpitas and SJW service areas that are not connected to each other. Connecting these systems would help significantly increase system reliability to both systems.

Additionally, SJW extended a recycled water pipeline to Northwood Park. Connecting this SJW pipeline to the City of Milpitas pipeline at Gibraltar and South Milpitas Boulevard would provide reliability to the City, should there be an issue near the BART crossing. This would also eliminate a dead end in the SJW distribution system.

Both reliability options should be further explored with Milpitas, SBWR, and SJW to see if an agreement to intertie the systems together can be achieved.

Expansion: Expansion of the SBWR distribution system in the City of Milpitas from Town Center to the east will require upgrades to specific pipelines on South Milpitas Boulevard, Corinthia Drive, Jacklin Road, and

Hillview Drive. These upgrades, shown in Figure 9, would increase the pipeline diameter in each location from 6-inches to 16 inches.

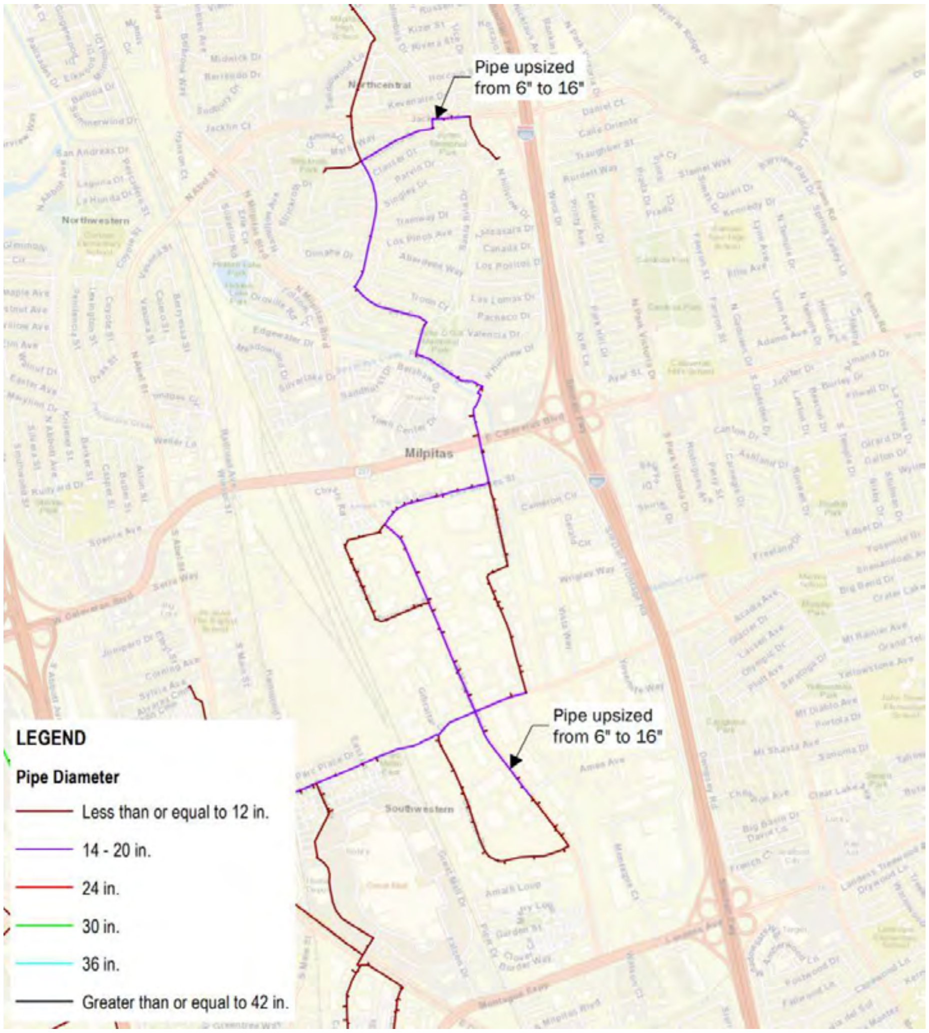

Pipe upsized from 6" to 16"
Northcentral
Northwestern
Milpitas
Pipe upsized from 6" to 16"
Southwestern
LEGEND
Pipe Diameter
Less than or equal to 12 in.
14 - 20 in.
24 in.
30 in.
36 in.
Greater than or equal to 42 in.

Figure 9. Proposed City of Milpitas Pipeline Infrastructure Projects

4.3.4 SJW improvements

The only pipeline improvement project required in the SJW service area to supply buildout conditions is located on Curtner Road and Tully Road (Figure 10). This upgrade is required to serve the proposed Alignment Q. Where there are existing pipelines on Tully and Curtner, these pipelines would need to be upsized to 36-inches in diameter.

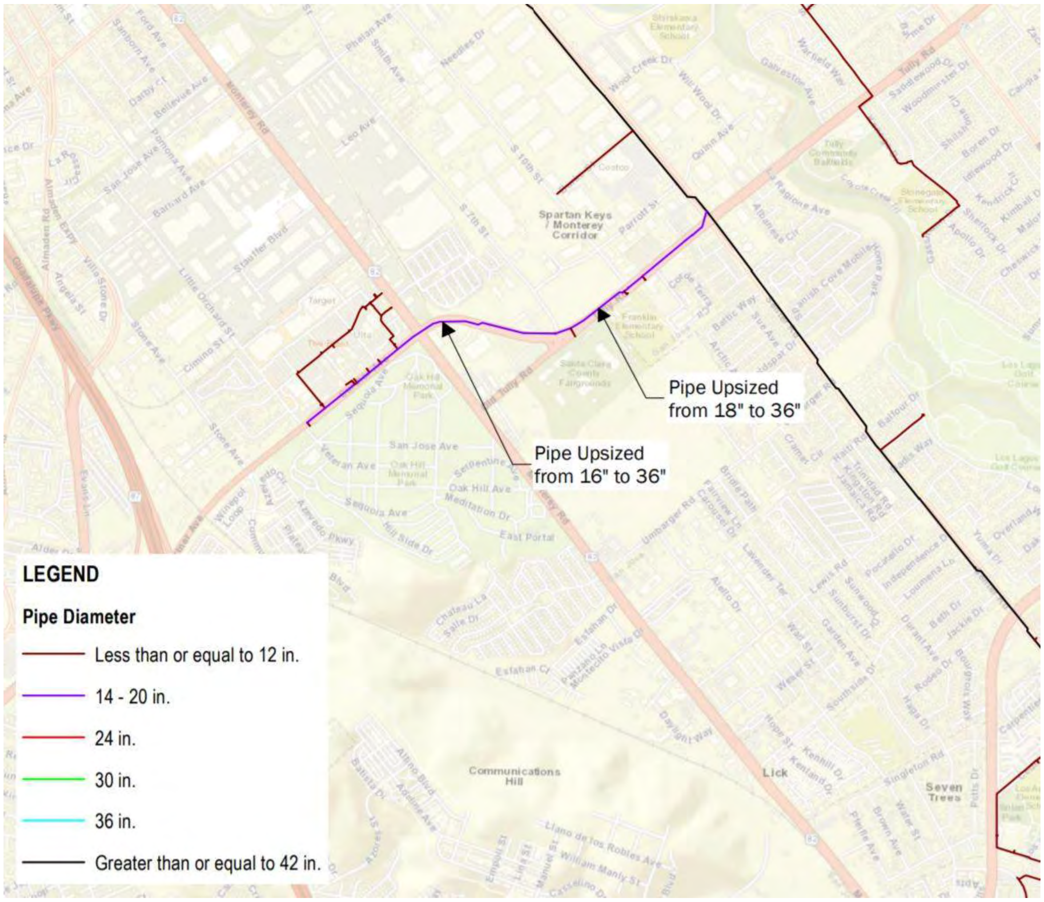


Figure 10. Proposed San Jose Water Company Pipeline Infrastructure Projects

Section 5: Model Results

The attached figures summarize the results and output of the hydraulic model. The figures included in the attachment present the following information.

- Minimum pressures – existing and buildout scenarios
- Maximum velocity – existing and buildout scenarios
- Pipeline diameters – existing and buildout scenarios
- Locations where buildout demands were placed in the model
- New infrastructure – City of Santa Clara
- New infrastructure – City of Milpitas
- New infrastructure – SJMWS
- New infrastructure – SJW

Additionally, an electronic copy of the hydraulic model in Infowater format is being transmitted to Valley Water and SBWR under a separate cover.

Attachment A summarizes the results and output of the hydraulic model, including the following information for existing conditions and the buildout scenario.

- Minimum pressures
- Maximum velocity
- Pipeline diameters
- Locations of new infrastructure as incorporated in the model to serve buildout demands for SJMWS, City of Santa Clara, SJW, and the City of Milpitas

Task 9.5 of the scope required answering a number of key questions and are presented below.

5.1 Near-Term NPR Additions

The CoRe Plan's Task 9 scope requested that HydroScience look at near term NPR additions within the service area of each retailer, with a focus on well-defined developments with significant water supply benefit. Modeling was to be performed without supplemental water supply to meet peak day conditions.

Analysis of the SBWR distribution system and known locations for additional recycled water demands provided by the retailers showed that system expansions proposed by the retailers are not expected to be cost-effective to construct by SBWR. Projects that are expected to be cost-effective are those constructed by others, which include the following:

- **Specific projects within the Santa Clara service area (1,638 AFY).** These projects represent about 1,638 AFY of additional demand. These demand estimates are based either on information submitted by the applicant or informed estimates by the City of Santa Clara. These projects generally represent new development, and could be conditioned by the City to connect their demands directly to the SBWR distribution system.
- **SJW recycled water projects (up to 5,703 AFY).** Implementation of the SJW recycled water projects would not result in any capital outlays by SBWR. It would require allocation of available capacity and/or implementation of projects to increase system reliability. SJW offered to construct the Mabury Station Tank and Pump Station Project at its cost to free up system capacity at the TPS. SBWR declined to execute a Wholesaler Retailer Agreement Amendment with SJW to receive this additional distribution storage and pumping. In exchange for receiving this storage and pumping, SJW wanted the ability to construct additional recycled water pipelines in its service area at new intertie locations, beginning first with Alignment E, then Alignments P, Q, and K in a subsequent Wholesaler Retailer Agreement

Amendment. Additionally, recycled water could be supplied by SJW to new developments that are large non-potable water users.

- **SJMWS and Milpitas.** There are no near-term projects that are being planned by SBWR within the SJMWS or Milpitas service areas.

5.2 Available Capacity

Without additional storage, system capacity is largely dependent on the ability of the TPS to supply water during the peak hour. Peak hour flow rates from the TPS are approximately 26.2 mgd in the hydraulic model existing scenario, which is delivering approximately 14,000 AFY. During 2020, it is believed that SBWR is currently delivering over 15,000 AFY and experiencing conditions where the TPS is delivering approximately 30 mgd during the peak hour.

The TPS has the capacity to deliver approximately 48 mgd with all pumps in service, or approximately 40 mgd when one of the larger pumps (900 hp) is not in service. The TPS should not be required to operate with all pumps in service. It is standard to have “n-1” reliability with pump stations.

For this analysis, we are assuming that the TPS has a firm capacity of approximately 40 mgd, equivalent to “n-1” capacity. The model assumes that the current peak hour demand is 26.2 mgd with an annual delivery of 14,000 AFY. Assuming that recycled water deliveries maintain a similar diurnal pattern in the future to those that are existing, it is estimated that SBWR could reliably deliver approximately 21,300 AFY of recycled water.

Additionally, this estimate of the annual volume that can be reliably be delivered with the existing recycled water distribution system is less than the buildout demand condition desired by SBWR. More distribution system storage will be required in order to supply the buildout condition.

It was noted that we do not recommend delivering this volume of recycled water without adding some combination of distribution system storage, supplemental water supplies, and additional TPS capacity. Adding reliability to a recycled water distribution system in any form increases the reliability and reduces the dependence of the system on any one single component.

5.3 Distribution System Storage

HydroScience recommends SBWR maintains a distribution system storage volume equivalent to the average day demand within that pressure zone. Based on the existing and buildout demand conditions, Table 3 presents the existing and buildout storage requirements by pressure zone.

During existing conditions, distribution system storage volumes are deficient in Zone 1 and satisfactory in Zones 2 and 3. At buildout conditions, most of the additional demand is going into Zone 1, which will exacerbate the existing storage deficiency. Zones 2 and 3 will have adequate storage at these buildout projections.

To connect 19 MG of additional distribution system storage in Zone 1, it is expected that all four of the storage projects identified in Section 4.1 – Corporation Yard (4 MG), Rabello (5 MG), Yerba Buena (4 MG), and Mabury (6 MG) be constructed to accommodate the buildout design condition. These four storage tanks would add 19 MG of distribution system storage to SBWR Zone 1.

SBWR Pressure Zone	Existing – 2017				Buildout– 2040			
	Average Day Demand (mgd)	Desired Storage (MG)	Actual Storage (MG)	Delta (MG)	Average Day Demand (mgd)	Desired Storage (MG)	Actual Storage (MG)	Delta (MG)
1	8.0	8.0	0	(8.0)	19.0	19.0	0	(19.0)
2	1.1	1.1	4	2.9	4.3	4.3	4.0	(0.3)
3	3.4	3.4	5.5	2.1	4.3	4.3	5.5	1.2
Overall	12.5	12.5	9.5	(3.0)	27.6	27.6	9.5	(18.1)

Table 3. SBWR Storage Requirements – Existing and Buildout

Attachment A: Project Location Maps and Model Results

1. SBWR Existing System – Minimum Junction Pressure
2. SBWR Existing System – Maximum Pipe Velocities
3. SBWR Existing System – Pipe Diameters
4. SBWR Buildout System – Minimum Junction Pressure
5. SBWR Buildout System – Maximum Pipe Velocities
6. SBWR Buildout System – Pipe Diameters
7. SBWR Buildout System – Planned Max Day Demands
8. City of Santa Clara – Buildout Infrastructure
9. City of Milpitas – Buildout Infrastructure
10. SJMWS – Buildout Infrastructure
11. SJW – Buildout Infrastructure

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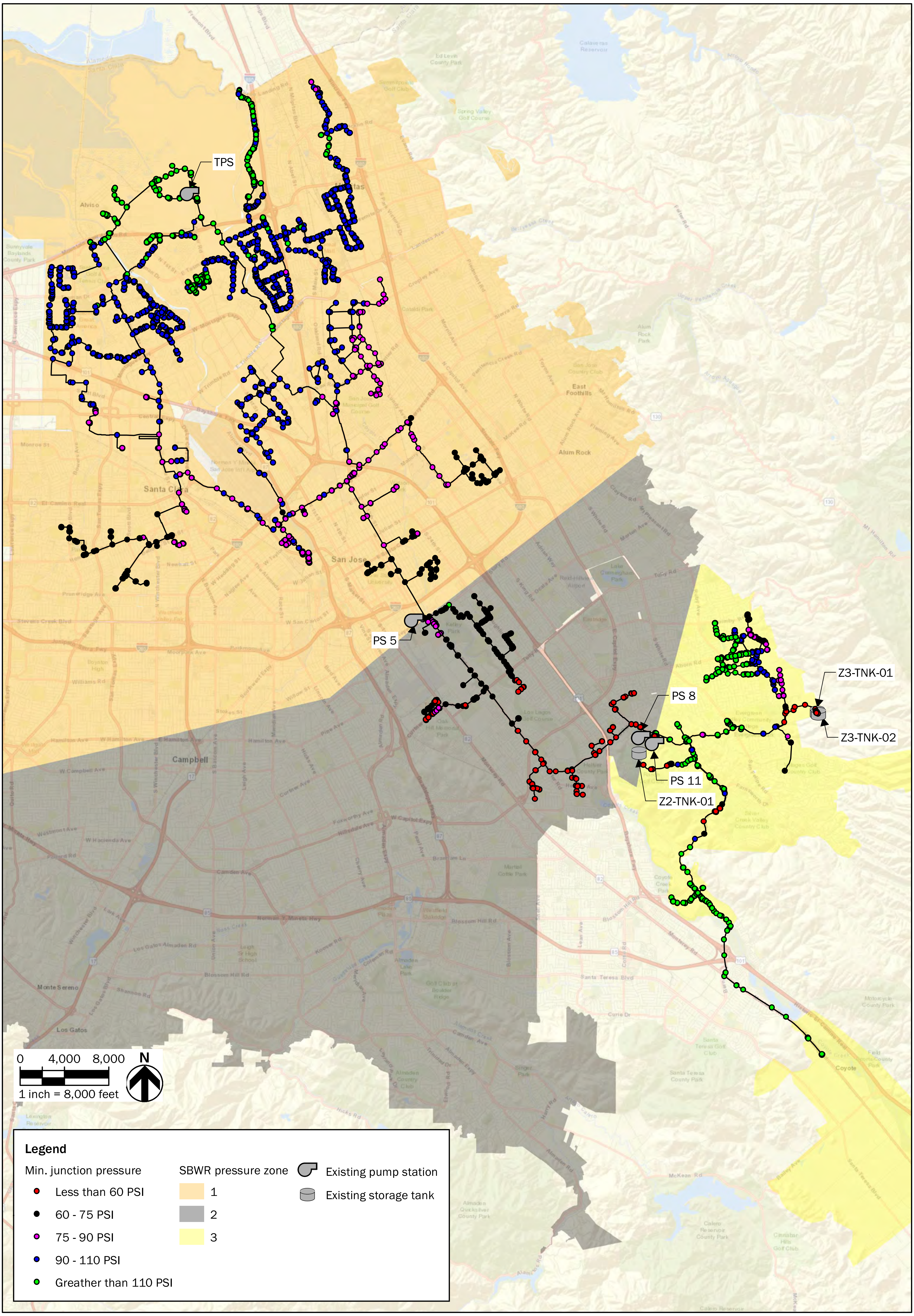
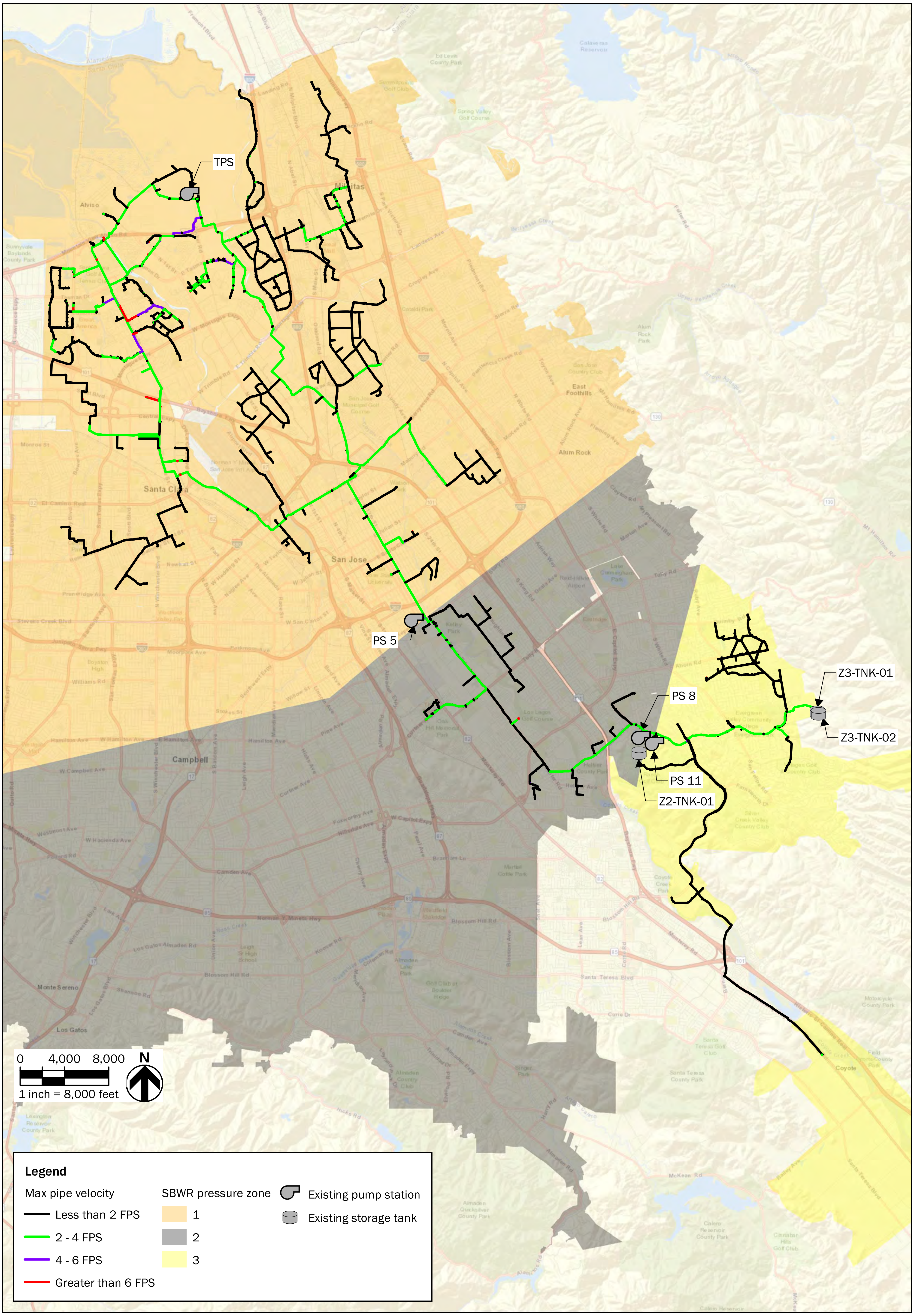
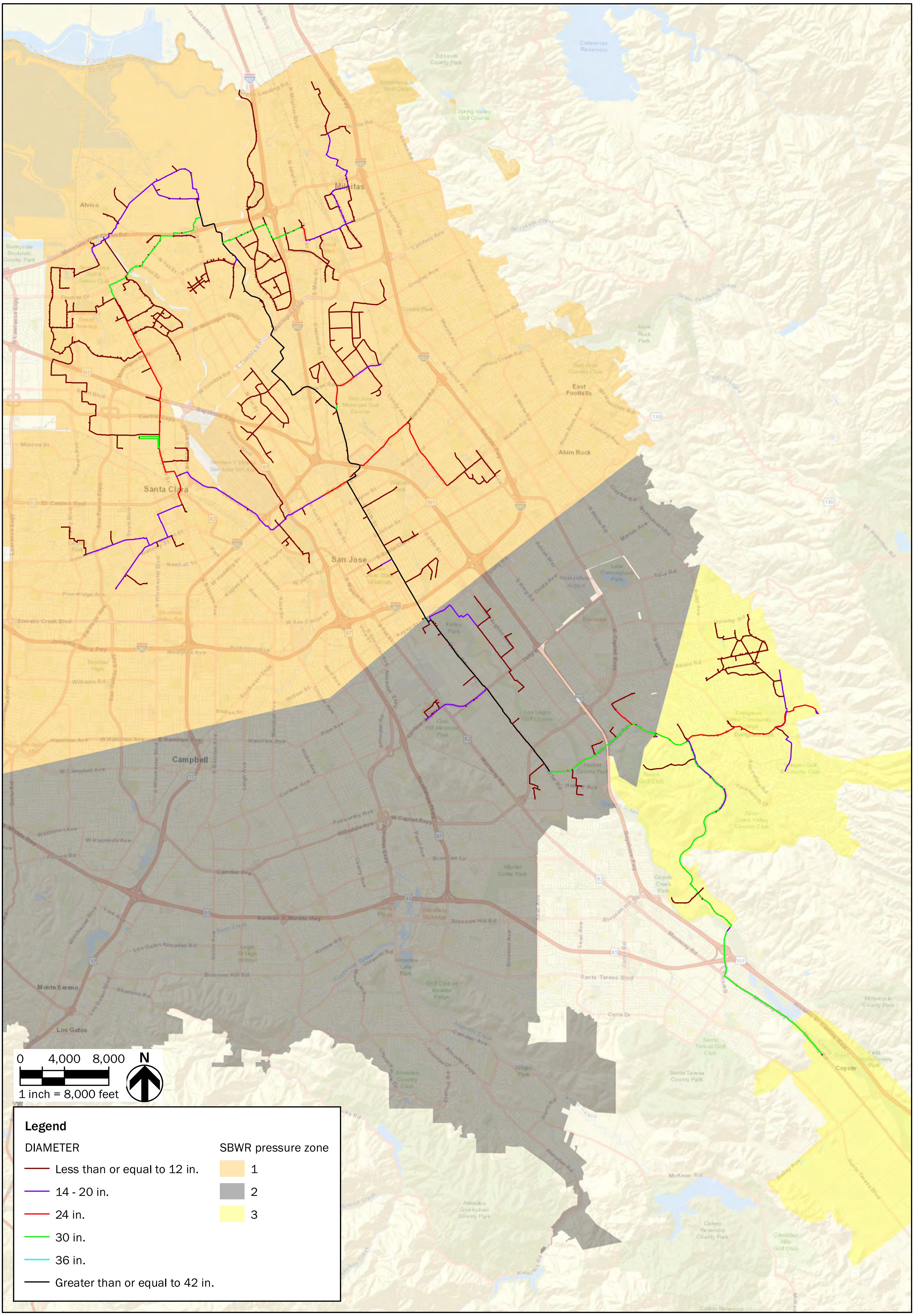


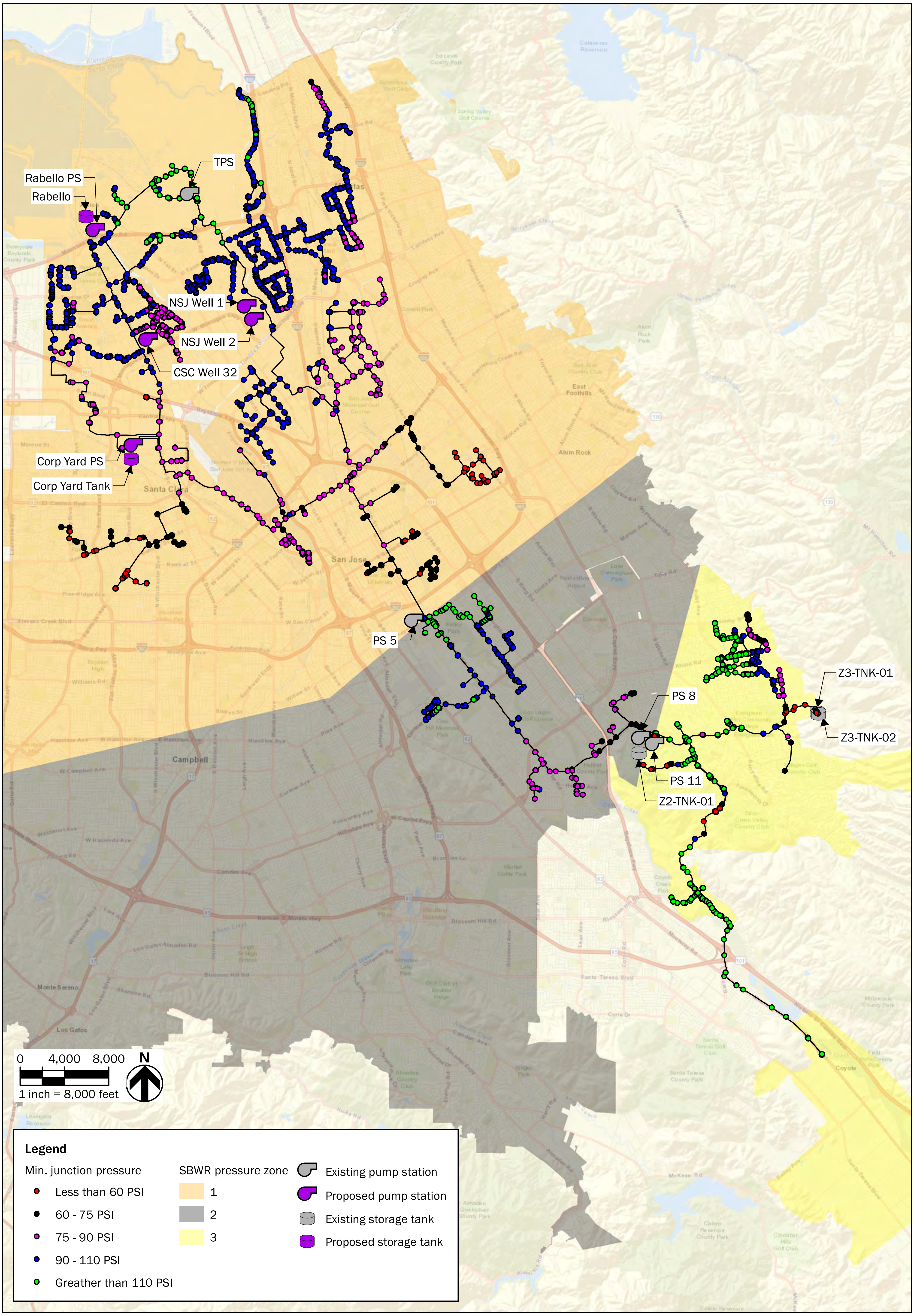
Valley Water
Countywide Water Reuse Master Plan
SBWR Existing System - Minimum Junction Pressure



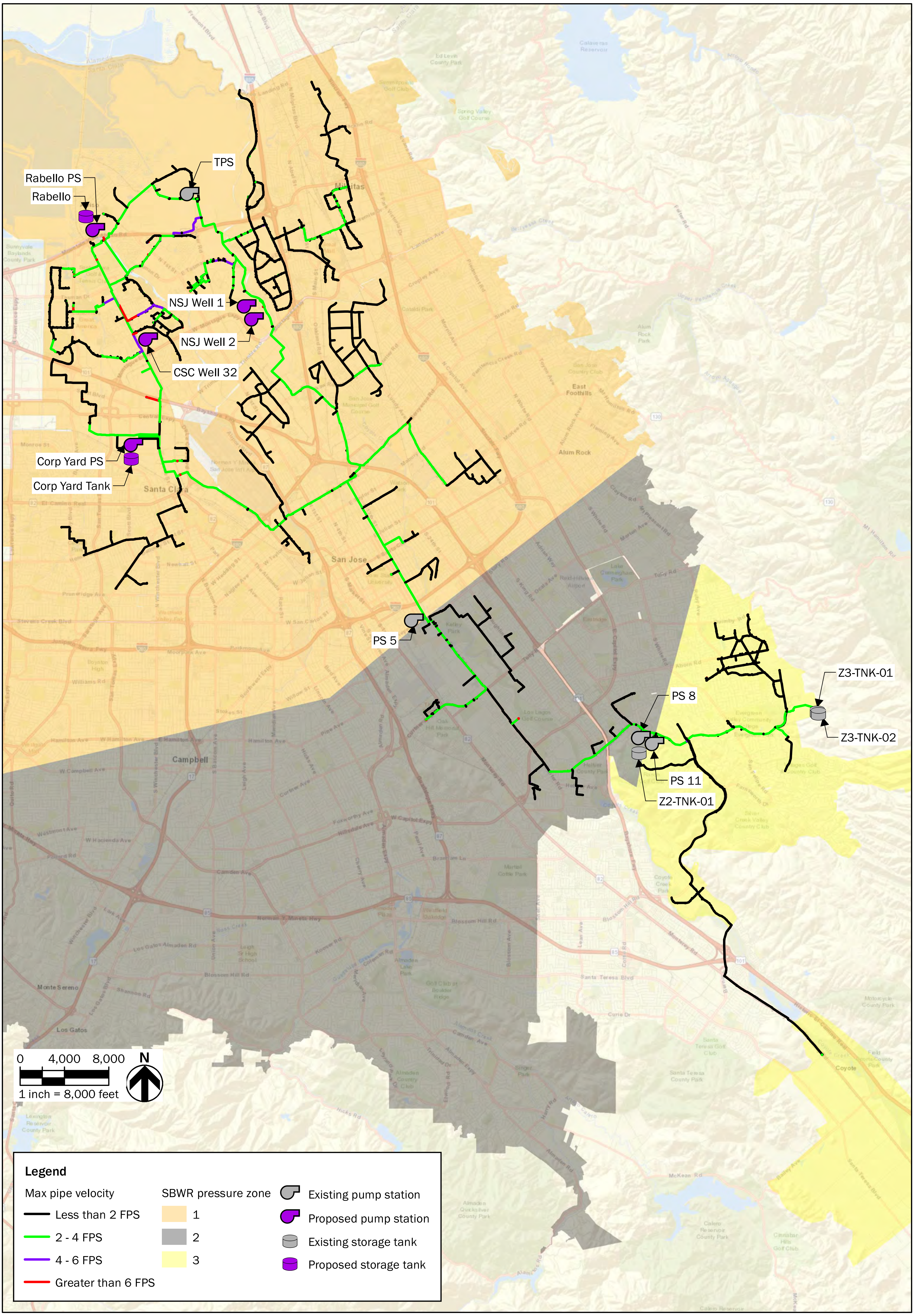
Valley Water
Countywide Water Reuse Master Plan
SBWR Existing System - Maximum Pipe Velocities



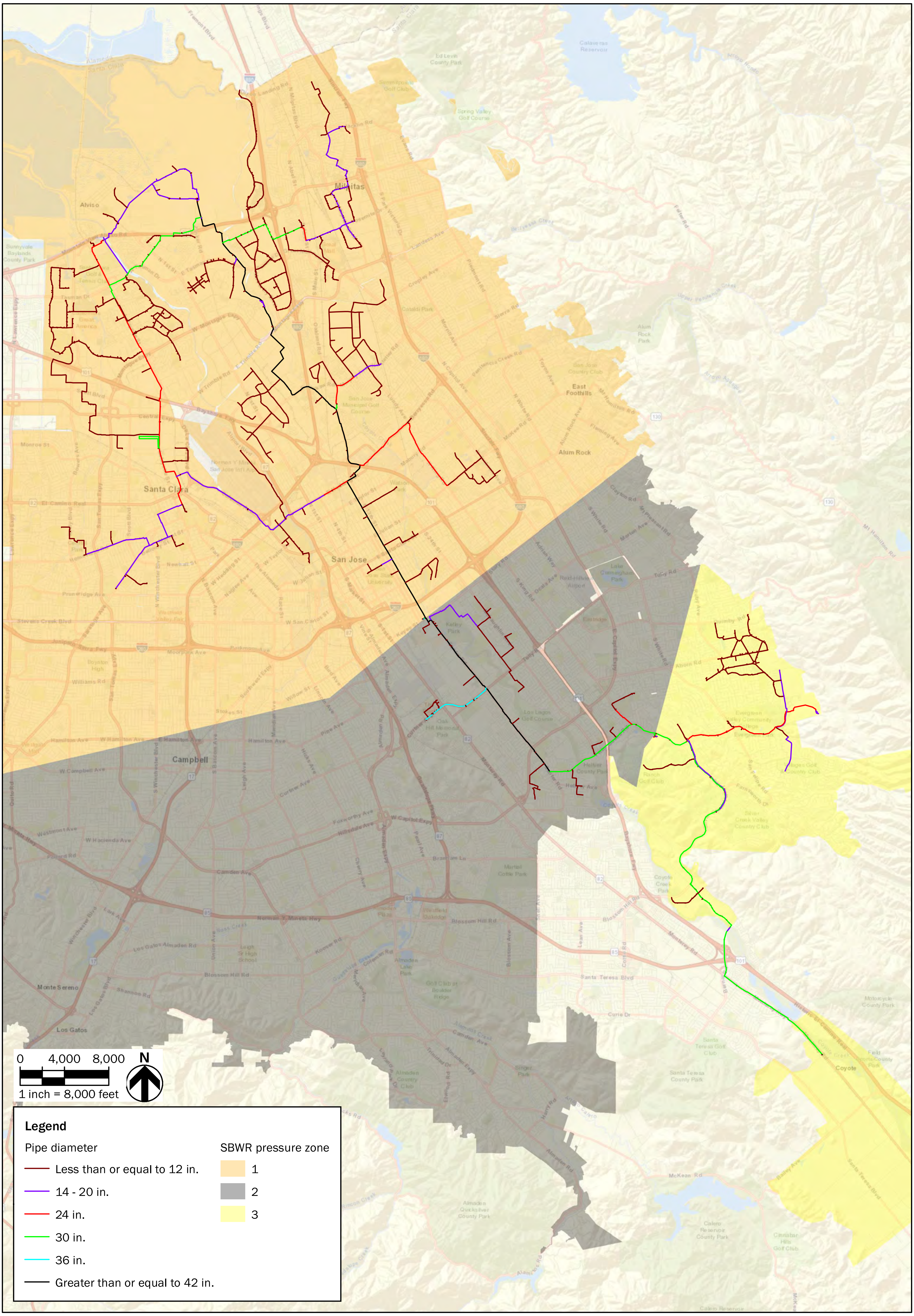
Valley Water
Countywide Water Reuse Master Plan
SBWR Existing System - Pipe Diameters



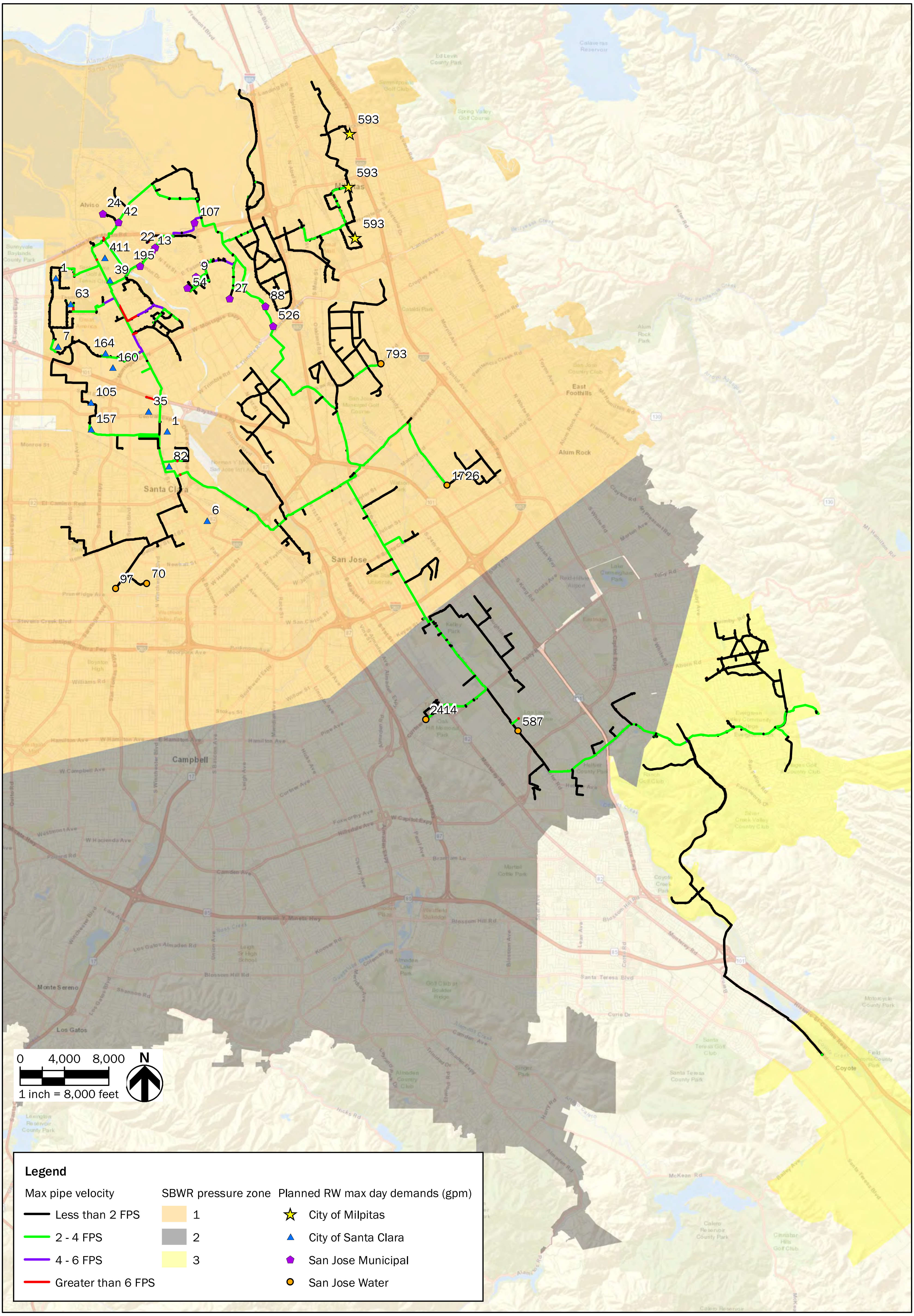
Valley Water
Countywide Water Reuse Master Plan
SBWR Buildout System - Minimum Junction Pressure



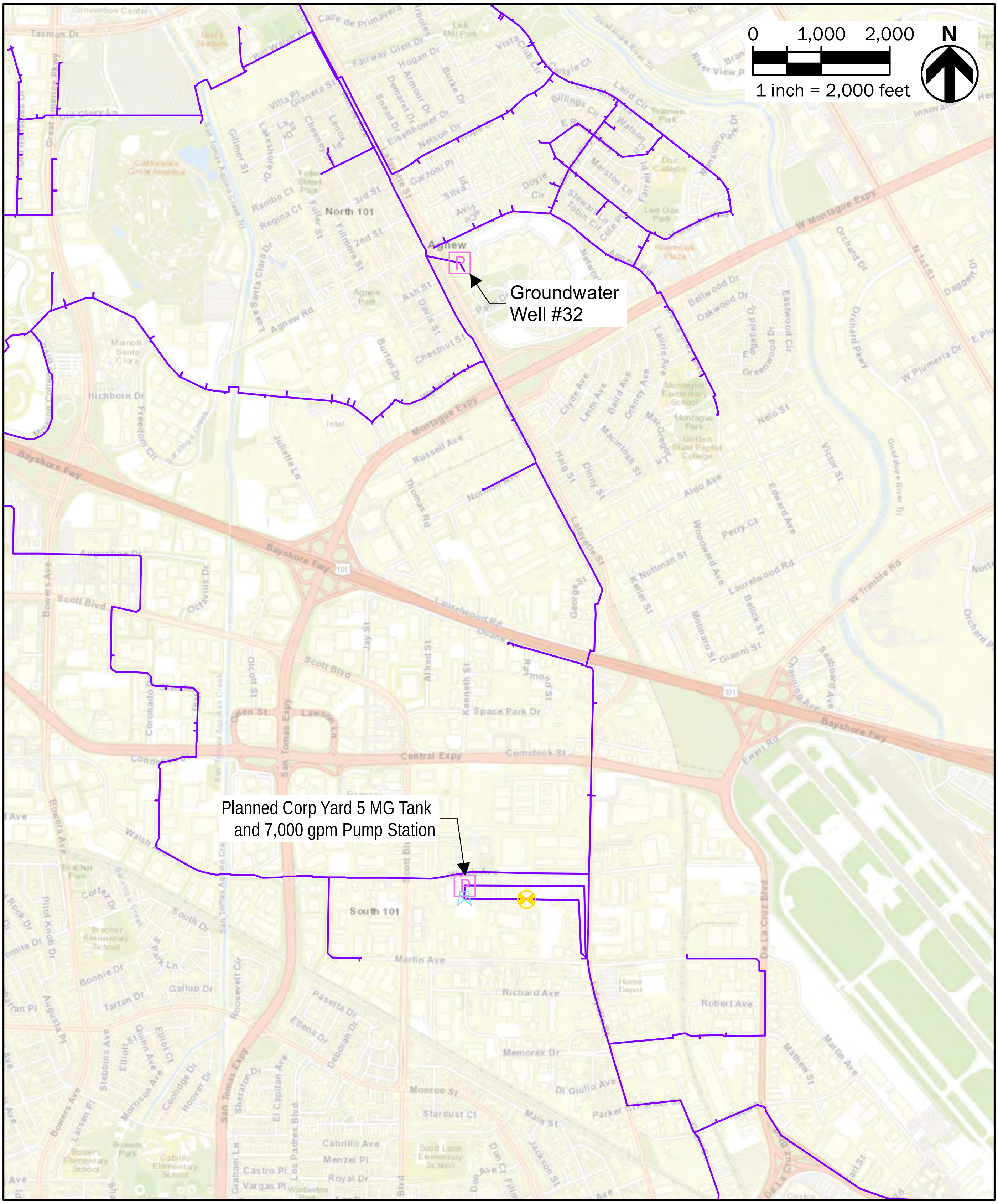
Valley Water
Countywide Water Reuse Master Plan
SBWR Buildout System - Maximum Pipe Velocities



Valley Water
Countywide Water Reuse Master Plan
SBWR Buildout System - Pipe Diameters

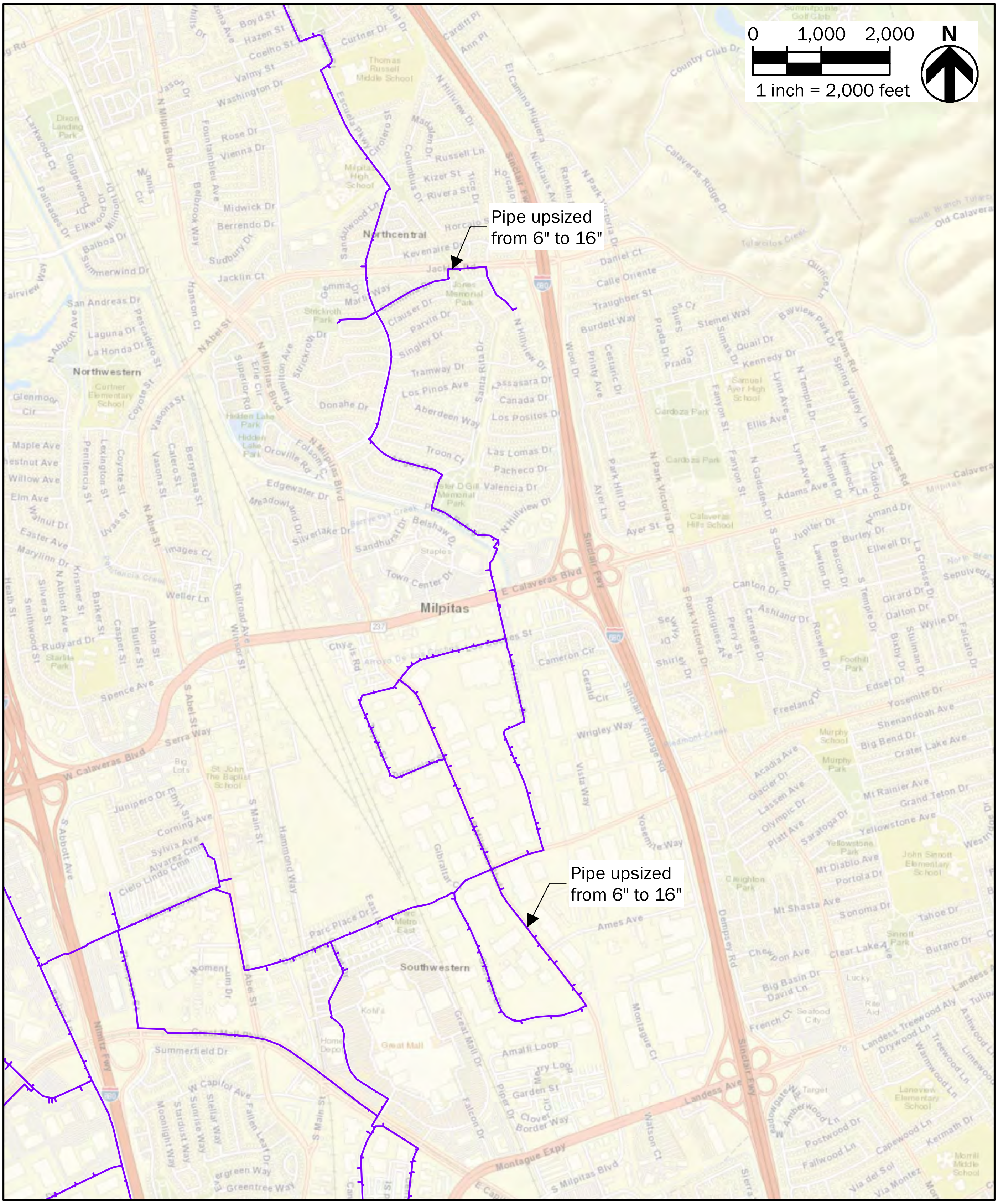


Valley Water
Countywide Water Reuse Master Plan
SBWR Buildout System - Planned Max Day Demands



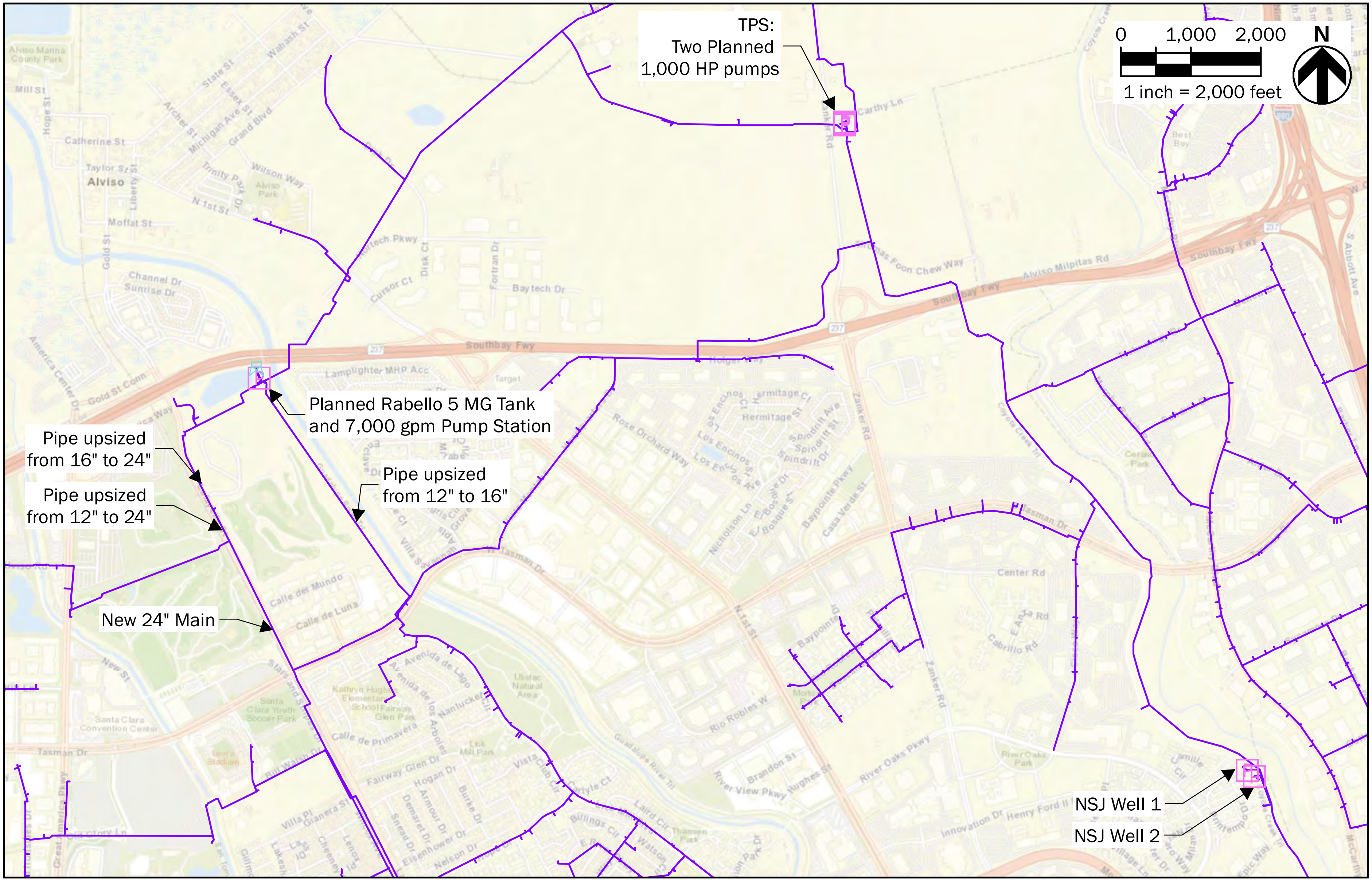
HydroScience

Valley Water
Countywide Water Reuse Master Plan
City of Santa Clara - Buildout Infrastructure



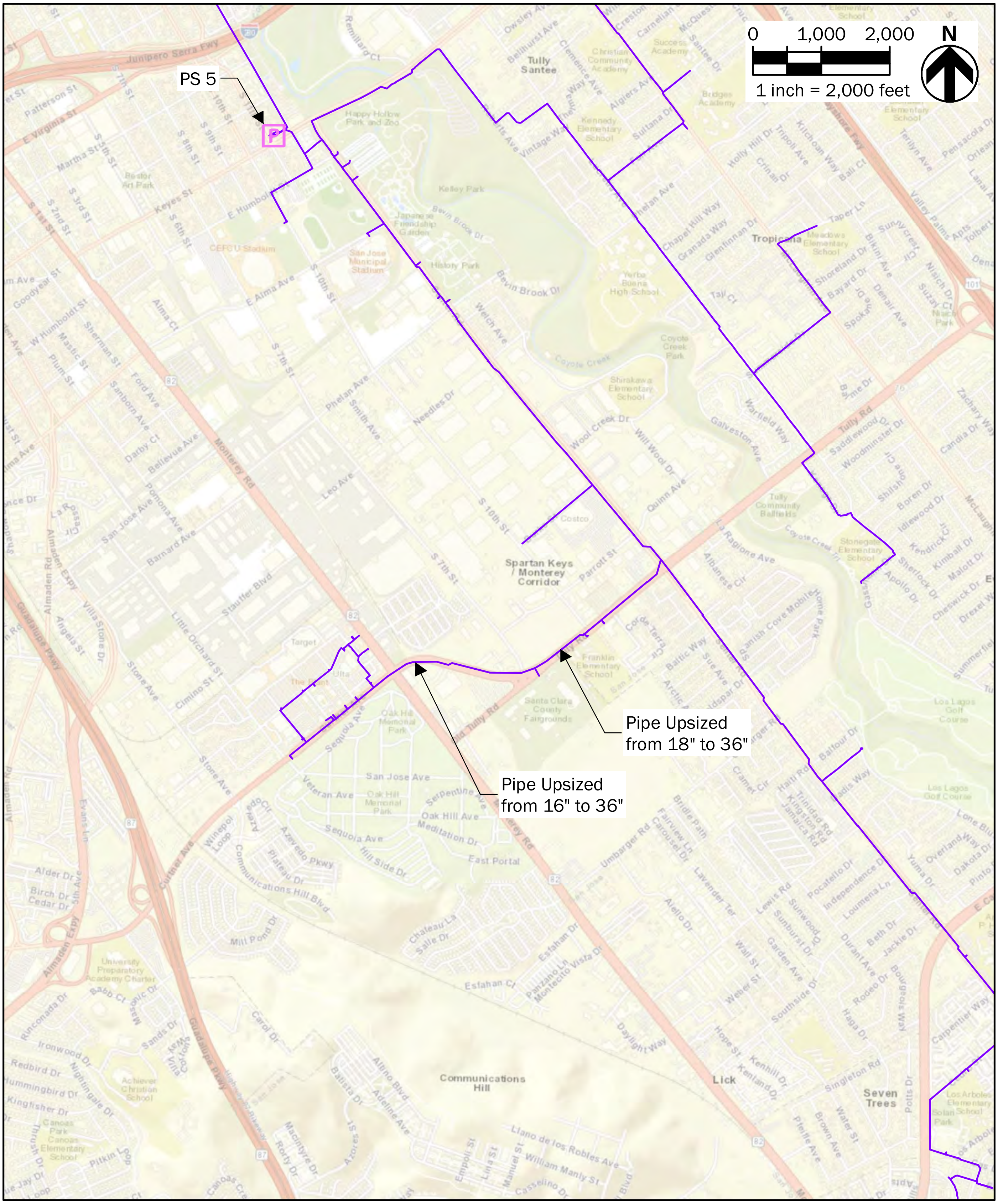
Valley Water
Countywide Water Reuse Master Plan
City of Milpitas - Buildout Infrastructure

HydroScience



HydroScience

Valley Water
Countywide Water Reuse Master Plan
San Jose Municipal Water System - Buildout Infrastructure



Valley Water
Countywide Water Reuse Master Plan
San Jose Water - Buildout Infrastructure

HydroScience

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Appendix D: Project Definition, Roles, and Responsibilities

75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

Technical Memorandum

Prepared for:	Santa Clara Valley Water District (Valley Water)
Project title:	Countywide Water Reuse Master Plan
Project no.:	4821 (Valley Water); 151772 (BC Internal)
Contract no.:	A4120A

Appendix D

Subject:	Project Definition, Roles, and Responsibilities
Date:	April 27, 2018 (reissued June 30, 2020)
To:	Miguel Silva, Valley Water Project Manager
From:	Jenny Gain, BC Team Project Manager
Copy to:	David Tucker, Valley Water Assistant Project Manager

Prepared by: Jenny Gain, Brown and Caldwell

Reviewed by: Mary Hoang, HydroScience Engineers

Limitations:

This document was prepared solely for Santa Clara Valley Water District (Valley Water) in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Table of Contents

Executive Summary 1

Section 1: Purpose and Scope 2

Section 2: Countywide Reuse Vision 3

2.1 Background 3
  2.1.1 District Mission 3
  2.1.2 History of Recycled Water Within Santa Clara County 4
  2.1.3 Valley Water Authority, Policies, and Strategies 6
  2.1.4 Existing Plans 8
  2.1.5 Master Plan 12
2.2 Study Area and Water Resources 15

Section 3: Roles and Responsibilities 18

3.1 Valley Water Roles and Responsibilities 18
3.2 Regulatory Responsibilities 19
3.3 Past and Current Reuse Partnerships 19
  3.3.1 Palo Alto/Mountain View Recycled Water System 19
  3.3.2 South Bay Water Recycling System 20
  3.3.3 South County Recycled Water System 21
  3.3.4 Sunnyvale Recycled Water System 22
  3.3.5 Other Agreements 23
3.4 Considerations for Future Agreements 23
3.5 Collaboration and Engagement 24
  3.5.1 Recycled Water Committees 25
  3.5.2 Partner Agencies 26
  3.5.3 Stakeholders 27
  3.5.4 Independent Advisory Panel 27
  3.5.5 Regulators 27
  3.5.6 Public 27

Section 4: Next Steps 28

Attachment A: Relevant Planning Studies (Reference List) ..... A

Attachment B: Past and Current Agreements List ..... B

List of Figures

Figure 2-1. The evolution of recycled water policies (local/county and state) and actions within Santa Clara County 4

Figure 2-2. Trends in non-potable recycled water deliveries: 1998 to 2016 5

Figure 2-3. Framework of Valley Water Ends Policies: Board decisions through implementation by Valley Water staff 6

Figure 2-4. Valley Water Ends policy, goal, objectives, strategies, and outcome measures related to water reuse 7

Figure 2-5. Santa Clara and Llagas Subbasins 9

Figure 2-6. Master Plan integration of relevant Valley Water and Partner Agency planning studies 12

Figure 2-7. Recycled water pathways 13

Figure 2-8. Water reuse program timeline as of April 2018 14

Figure 2-9. Study area and existing recycled water systems 16

Figure 2-10. Existing Santa Clara County recycled and purified water suppliers 17

Figure 3-1. Levels of engagement to guide Master Plan development 25

Figure 3-2. How Valley Water's Board and its recycled and purified water board committees interact 26

List of Tables

Table 3-1. Valley Water Roles and Responsibilities Pertaining to Water Reuse 18

Table 3-2. Critical Path Considerations for Partnerships with Recycled Water Producers 24

Table A-1. Valley Water-Provided References Used in Project Definition, Roles, and Responsibilities TM A-1

Table B-1. Past and Current Agreements between Valley Water and External Partners B-1

List of Abbreviations

ABAG	Association of Bay Area Governments
AF	acre-foot/feet
AFY	acre-foot/feet per year
AWPF	advanced water purification facility
BARR	Bay Area Regional Reliability
BAWSCA	Bay Area Water Supply and Conservation Agency
BAO	Board Appointed Officer
CEO	Chief Executive Officer
CIP	capital improvement program
County	Santa Clara County
DDW	Division of Drinking Water
DPR	direct potable reuse
DWR	(California) Department of Water Resources
EIR	environmental impact report
EL	Executive Limitation
ELG	Executive Leadership Group
IAP	Independent Advisory Panel
IPR	indirect potable reuse
IRWM	integrated regional water management
JWRC	Joint Recycled Water Committee
L	liter(s)
Master Plan	Countywide Water Reuse Master Plan
mg	milligram(s)
mgd	million gallons per day
MOU	memorandum of understanding
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NWRI	National Water Research Institute
PA/MV RWS	Palo Alto/Mountain View Recycled Water System
PPG	Project Partner Group
PR	potable reuse
Project	Countywide Water Reuse Master Plan Project
RO	reverse osmosis
ROCM	reverse osmosis concentrate management
RWC	Recycled Water Committee
RWF	Regional Wastewater Facility
RWPAC	Recycled Water Policy Advisory Committee
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SFB	San Francisco Bay
SFEP	San Francisco Estuary Partnership
SFPUC	San Francisco Public Utilities Commission
SJWC	San Jose Water Company
Strategic Plan	Northwest County Recycled Water Strategic Plan
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TF	Task Force
TM	technical memorandum
TPAC	Treatment Plant Advisory Committee
UWMP	Urban Water Management Plan
WPCP	water pollution control plant
WRA	water reuse alternative
WSCP	Water Shortage Contingency Plan
Valley Water	Santa Clara Valley Water District

Executive Summary

The Countywide Water Reuse Master Plan (Master Plan) aims to improve water supply reliability through water reuse for Santa Clara County in collaboration with recycled water producers, wholesalers, retailers, users, and other interested parties. The Master Plan will identify how much water will be available for potential potable reuse development and non-potable reuse expansion, the optimal allocation between potable and non-potable reuse, options for system integration, recommendations for building upon non-potable reuse projects and creating new potable reuse projects, and proposals for governance model alternatives, including roles and responsibilities. This technical memorandum will be used to inform the final Master Plan to be completed in early 2021 to guide reuse in the County through 2040.

Building on the Success of Existing Partnerships

Santa Clara Valley Water District (Valley Water) policies include a goal to meet at least 10 percent of the County's total water demands by 2025 using water reuse. Valley Water's Water Supply Master Plan 2040 includes a reuse target to achieve 33,000 acre-feet per year (AFY) of non-potable reuse and 24,000 AFY of additional reuse in the County by 2040. To achieve this goal, Valley Water is building on its partnerships with four non-potable reuse systems in the County, referred to as Partner Agencies, to integrate existing plans and infrastructure. The Partner Agencies include:

1. **Palo Alto/Mountain View Recycled Water System (RWS).** Valley Water is currently working with Palo Alto and Mountain View to evaluate water reuse alternatives, including planned construction of a 1.25 to 2.5 million gallons per day Advanced Water Purification Facility (AWPF) near the Palo Alto Regional Water Quality Control Plant to reduce salinity of recycled water, and a potential larger regional AWPF to produce purified water for future potable reuse.
2. **South Bay Water Recycling (SBWR).** SBWR is a collaboration between the San José/Santa Clara Regional Wastewater Facility (RWF) and Valley Water. The RWF produces recycled water for SBWR to sell to retailers, including the City of San José, City of Milpitas, San Jose Water Company, and the City of Santa Clara. In 2014, Valley Water also collaborated with the City of San José in creating the Silicon Valley Advanced Water Purification Center, which produces purified water currently added back into the SBWR system to improve water quality.
3. **South County Regional Wastewater Authority (SCRWA).** In 1999, SCRWA partnered with Valley Water to create a master plan and capital improvement program, and agreed Valley Water would sell by wholesale recycled water produced by SCRWA to the City of Gilroy. Valley Water has also partnered with entities in the Gilroy area to construct new pipelines and extend the South County RWS.
4. **Sunnyvale RWS.** Starting in 2013, Valley Water partnered with Sunnyvale on the Wolfe Road pipeline design and construction. The pipeline is designed to deliver recycled water from the RWS to Apple Inc. in Cupertino, with Valley Water as the wholesaler and California Water Company as the retailer. Valley Water and Sunnyvale are jointly evaluating additional water reuse alternatives, including an AWPF near the Sunnyvale Water Pollution Control Plant.

Collaborating to Advance Water Reuse in Santa Clara County

In developing the Master Plan, Valley Water is leading an engagement strategy that involves staff and executive-level participation from Partner Agencies, along with a diverse group of stakeholders, regulators, an independent advisory panel, and the public. The outreach process will document commitments and future goals, acknowledge and find solutions to barriers, and define common goals. Achieving substantial agreement on conceptual project alternatives and identifying alternatives for preliminary design will be key to producing a successful Master Plan and implementing water reuse solutions for years to come.

Section 1: Purpose and Scope

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) Project (Project) to improve water supply reliability through water reuse for Santa Clara County's (County's) nearly 2 million residents and growing economy. Valley Water's strategy for meeting this goal is twofold: (1) to integrate and expand existing recycled water systems and (2) to develop purified water systems within Santa Clara County, in partnership with recycled water producers, wholesale and retail water suppliers, end users, and other interested parties. The Master Plan will provide a framework to make collaborative decisions and implement integrated actions to increase water supply reliability throughout the region. Decisions will be informed through technical assessment of key criteria applied to allocate available wastewater flows and integrate centralized/decentralized and potable/non-potable options. The Master Plan's planning horizon extends through 2040.

There are many drivers for diversifying and expanding the county's water supply portfolio, including population/economic growth, increasing climate uncertainty, and other challenges to supply resilience. Recent technological advancements and regulatory developments have made it possible for Valley Water to pursue water reuse as a viable local, drought-resistant supply.

To address several specific objectives (adjacent text box), the scope of this Master Plan involves developing interim deliverables that build on one another as elements of the Master Plan, including the following technical memoranda (TM) and reports and their respective purpose.

- **Project Definition, Roles and Responsibilities** – Establishes the project's purpose and describe roles and responsibilities of Valley Water and its Partner Agencies.
- **Regulations Framework** – Describes key regulations applicable to non-potable and potable reuse applications that must be considered when developing water alternatives.
- **Baseline Analysis** – Establishes a Countywide baseline of existing reuse facilities and projects, assesses reuse supply availability, and identifies information gaps.
- **Geotechnical and Geo-Environmental Preliminary Study** – Compiles existing information about geotechnical and geo-environmental characteristics of a potential reuse facility site in Sunnyvale
- **Modeling Plan** – Describes the planned approach for updating Partner Agencies' existing hydraulic models of non-potable reuse systems, and the **Hydraulic Model Results** that provide completed and calibrated hydraulic models for all non-potable reuse systems in the County, and summarizes the results of hydraulic model simulations.

Project purpose:
To improve Santa Clara County's water supply reliability through water reuse

Master Plan objectives:

- **Determine reuse supply availability and benefits.** Identify sources and amounts of water available for reuse; the appropriate split between potable and non-potable reuse; and regional, Valley Water, and local-level benefits from NPR and PR.
- **Evaluate potential regional integration.** Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.
- **Guide system expansion through interagency agreements and governance**. Analyze the economics of project alternatives and explore cost-sharing opportunities
- **Generate regional support for the Master Plan via coordination and outreach.** Improve public perception of water reuse through outreach programs.

- **Conceptual Alternatives** – Assesses the County's reuse market, identifies and evaluates conceptual project alternatives, groups project alternatives into portfolios, describes the portfolios' prioritization and assessment methodology, and identifies a residuals management plan for alternatives involving advanced water purification facility (AWPF) options.
- **Preliminary Draft Master Plan** – Provides a high-level summary of items 1 through 4 above to update Valley Water's Board.
- **Feasible Project Portfolios** – Presents preliminary designs, costs, and a risk assessment and evaluation of project portfolios.
- **Draft Master Plan Report** – Presents a summary of items 1 through 8 above (including interim TMs and studies as appendices) and assesses regulatory compliance options.
- **Final Master Plan Report** – Refines the Draft Master Plan considering feedback from Valley Water, Partner Agencies, and external stakeholders.

For the purposes of this Master Plan, terms are defined as follows:

- **Recycled water or non-potable reuse (NPR)** – Water that originated from homes and businesses as municipal wastewater and has undergone a high degree of treatment at a reclamation facility to meet specific water quality standards so that it can be beneficially reused for a variety of non-potable purposes.
- **Purified water or potable reuse (PR)** – Water of wastewater origin treated with methods at least as effective as membrane filtration, reverse osmosis (RO), advanced oxidation, disinfection, or other equivalent treatment as approved by State Water Resources Control Board Division of Drinking Water (DDW). Advanced levels of treatment are used so that the purified water can be added to water supplies and ultimately used for drinking water.
- **Enhanced Recycled Water (NPR+)** – NPR water that has been blended with PR water to reduce total dissolved solids (TDS) and improve water quality.
- **Reuse** – As a shorthand, the term reuse applies to both NPR and PR.

Section 2: Countywide Reuse Vision

For more than a decade, Valley Water has methodically advanced water reuse in the county by participating in planning efforts, developing wholesale recycled water programs, and constructing new infrastructure. Now, Valley Water is broadening the reuse vision to focus on a collaborative, countywide strategy. Leveraging existing partnerships, expertise, and technical resources, the Master Plan will identify reliable sources of water supply to increase regional self-reliance and integrated water management in Santa Clara County.

Countywide reuse vision:

> "A collaboration to integrate and expand recycled and purified water as a local, reliable, environmentally adaptive, drought-resistant water supply and guide strategic investment of public funds over the next 20 years."

2.1 Background

Understanding the countywide reuse vision requires understanding the history of recycled water use in Santa Clara County, the roles and responsibilities of Valley Water, and existing recycled water planning documents.

2.1.1 District Mission

Valley Water's mission is to provide safe, clean water for a healthy Santa Clara County community, environment, and economy. The county's water supplies originate from multiple sources, including naturally occurring groundwater, local surface water, imported water (e.g., water imported from the Sacramento-San

Joaquin Delta), and local recycled water. As policies and public perceptions have progressed over time, recycled water has become an integral component of Valley Water's existing and future water supply portfolio.

2.1.2 History of Recycled Water Within Santa Clara County

Major exploration and evaluation of water reuse as a drought-resistant water supply in the county began in the 1970s (Figure 2-1).

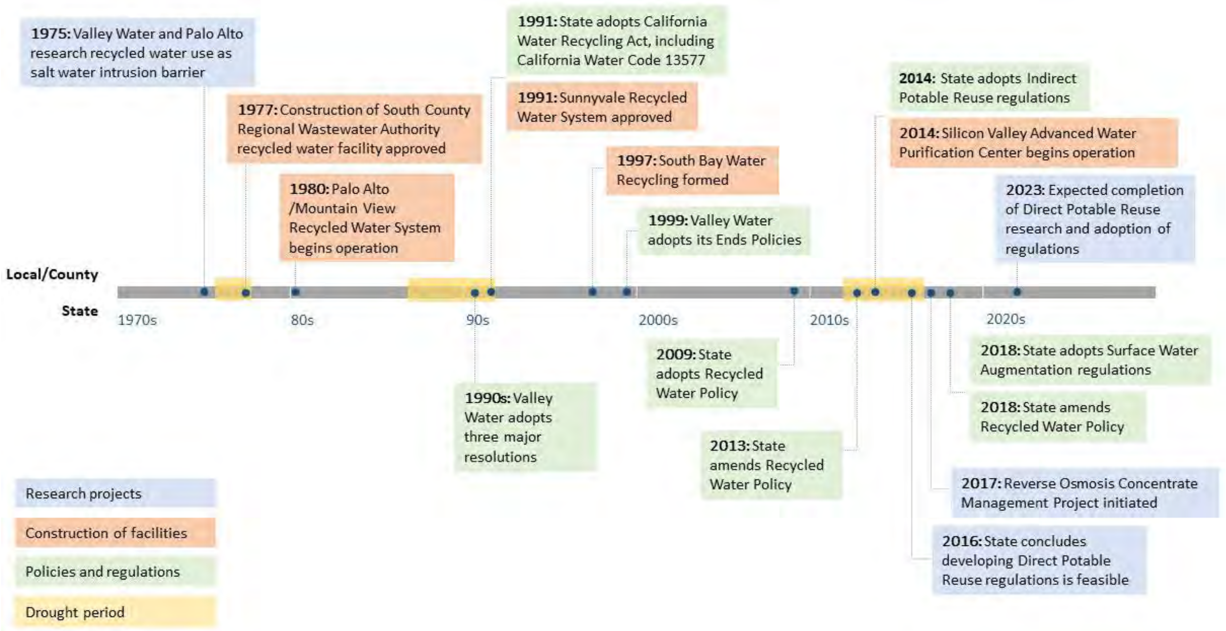

1975: Valley Water and Palo Alto research recycled water use as salt water intrusion barrier
1977: Construction of South County Regional Wastewater Authority recycled water facility approved
1980: Palo Alto /Mountain View Recycled Water System begins operation
1991: State adopts California Water Recycling Act, including California Water Code 13577
1991: Sunnyvale Recycled Water System approved
1997: South Bay Water Recycling formed
1999: Valley Water adopts its Ends Policies
2014: State adopts Indirect Potable Reuse regulations
2014: Silicon Valley Advanced Water Purification Center begins operation
2023: Expected completion of Direct Potable Reuse research and adoption of regulations
Local/County
State
1970s
80s
90s
2000s
2010s
2020s
1990s: Valley Water adopts three major resolutions
2009: State adopts Recycled Water Policy
2013: State amends Recycled Water Policy
2018: State adopts Surface Water Augmentation regulations
2018: State amends Recycled Water Policy
2017: Reverse Osmosis Concentrate Management Project initiated
2016: State concludes developing Direct Potable Reuse regulations is feasible
Research projects
Construction of facilities
Policies and regulations
Drought period

Figure 2-1. The evolution of recycled water policies (local/county and state) and actions within Santa Clara County

In 1975, Valley Water and Palo Alto constructed an advanced wastewater reclamation pilot plant to research the feasibility of using recycled water as a saltwater intrusion barrier. Drought conditions in the late 1970s led to the construction of the first recycled water facility in the county, the South County Recycled Water System (RWS) located in Gilroy to support agricultural irrigation. Several years later, the Palo Alto/Mountain View Recycled Water System (PA/MV RWS) began operation. Changes to state discharge regulations, coupled with population and business growth, led to construction of the City of Sunnyvale RWS in 1991 and the formation of South Bay Water Recycling (SBWR) in 1997, which treats effluent from the San José/Santa Clara Regional Wastewater Facility (RWF) for NPR. These four separate public water reuse systems still deliver recycled water within the county today, and were developed to meet the individual water supply and wastewater discharge needs of each of the stakeholder agencies within these service areas.

Valley Water adopted three major resolutions in the 1990s in support of recycled water use:

- Resolution 90-62 supported recycled water as a new supply (1990)
- Resolution 93-55 adopted policy for non-potable recycled water (1993)
- Resolution 93-55 was rescinded and replaced with Resolution 97-60, which reaffirmed Valley Water's commitment to recycled water (1997)

These resolutions marked Valley Water's initial recycled water policies and continue to guide Valley Water today.

In 2006, Valley Water worked with City of San José on planning an advanced recycled water facility. In 2014 (during the most recent drought cycle), Valley Water, in partnership with the City of San José, constructed the Silicon Valley Advanced Water Purification Center (SVAWPC), an 8 million gallon per day (mgd), state-of-the-art advanced water treatment facility that includes microfiltration, RO, and ultraviolet light disinfection. The facility also includes a pilot-scale advanced oxidation processes system. SVAWPC has been used to test and demonstrate the continued performance of advanced treatment technologies for producing highly treated water (purified water) to be used for indirect potable reuse (IPR) and/or potential direct potable reuse (DPR) applications. SVAWPC currently sends purified water to the SBWR system for NPR water quality enhancement (NPR+).

In 2017, Valley Water initiated a reverse osmosis concentrate management (ROCM) project to evaluate viable alternatives for managing RO concentrate from potential advanced water purification facilities that could be built in the county. The ROCM project includes evaluating treatment alternatives and RO concentrate discharge options. Valley Water is also exploring innovative RO concentrate treatment technology through a pilot-scale engineered open-cell treatment system at SVAWPC.

The successful operation of SVAWPC, along with these advanced technology and research studies, have established a foundation for regional discussions on the feasibility and development of PR projects. Furthermore, recent statewide regulatory developments have put the future feasibility of developing PR projects within the current planning horizon.

Historical recycled water delivery data for the four NPR systems and SVAWPC are shown on Figure 2-2. While purified water produced by SVAWPC is currently blended with SBWR recycled water, Figure 2-2 identifies SVAWPC production in blue to distinguish its volume. As the majority of non-potable recycled water in Santa Clara County is used for outdoor irrigation, recycled water demand tends to increase during periods of drought (such as 2012-2014).

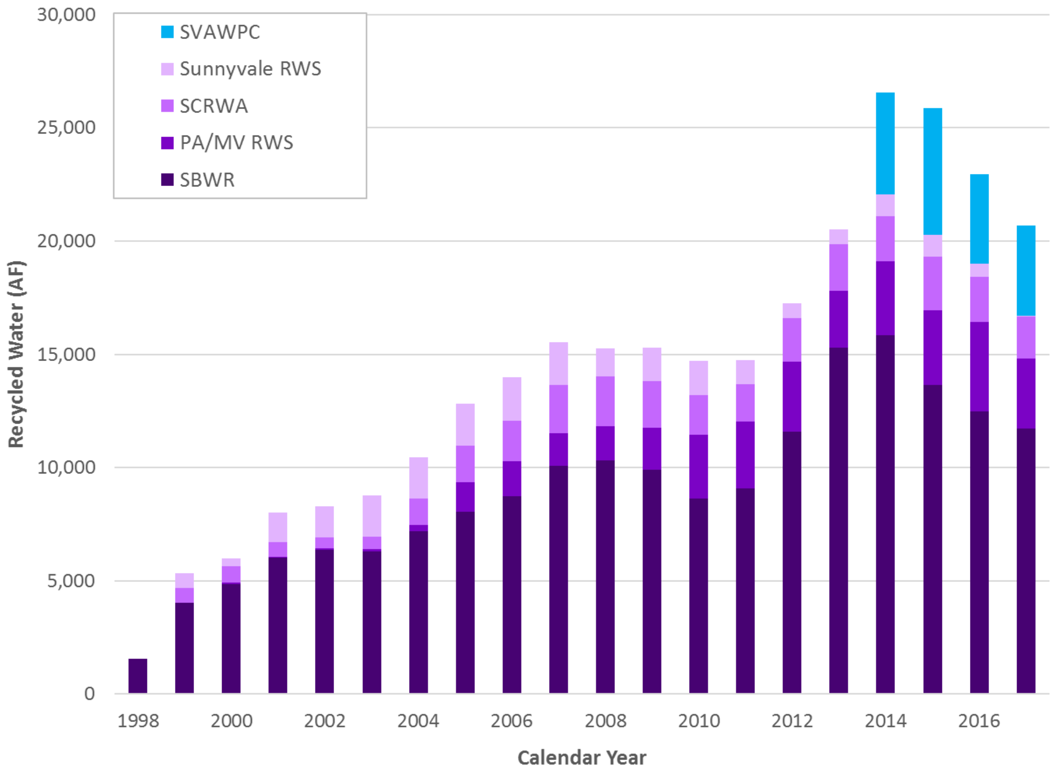


Figure 2-2. Trends in non-potable recycled water deliveries: 1998 to 2016

2.1.3 Valley Water Authority, Policies, and Strategies

Valley Water's authority, structure and Board-directed policies have an influence on all of Valley Water's projects, including the Master Plan. Valley Water staff and Board/committee members have also developed a specific strategy surrounding water reuse that will guide the Master Plan.

2.1.3.1 District Act

The District Act defines Valley Water's authority and responsibility to conserve and manage recycled water; to obtain, retain, protect, and recycle treated wastewater; to store water in surface or underground reservoirs; and to conserve, reclaim, recycle, distribute, store, and manage water for present and future use within Valley Water. These objectives have been further refined through management plans, policies, and agreements with various stakeholders within the county.

2.1.3.2 Board's Ends Policies

Valley Water's commitment to expand the use of recycled water in Santa Clara County was reaffirmed through the Board's adoption of its Ends Policies in 1999. These Ends Policies describe the mission, outcomes, or results to be achieved by Valley Water staff. Board Appointed Officer (BAO) interpretations, including the Chief Executive Officer's (CEO) interpretations, further guide implementation of the Ends Policies by identifying strategies and outcome measures (Figure 2-3). Ultimately, Ends Policies influence Valley Water spending; Executive Limitation (EL)-4 states that financial planning must not deviate from Board's Ends Policies or fail to be derived from a multi-year plan.

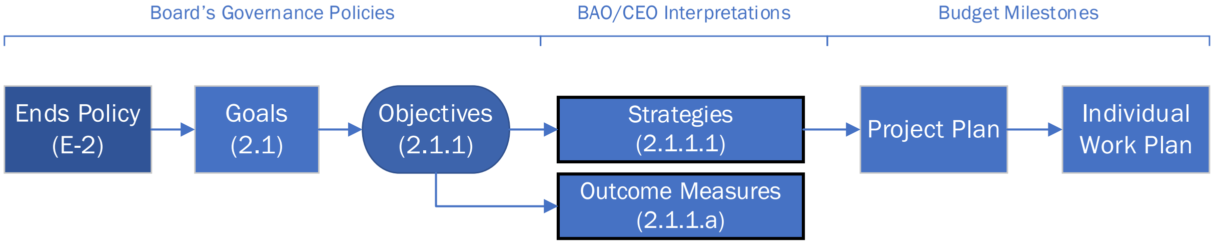
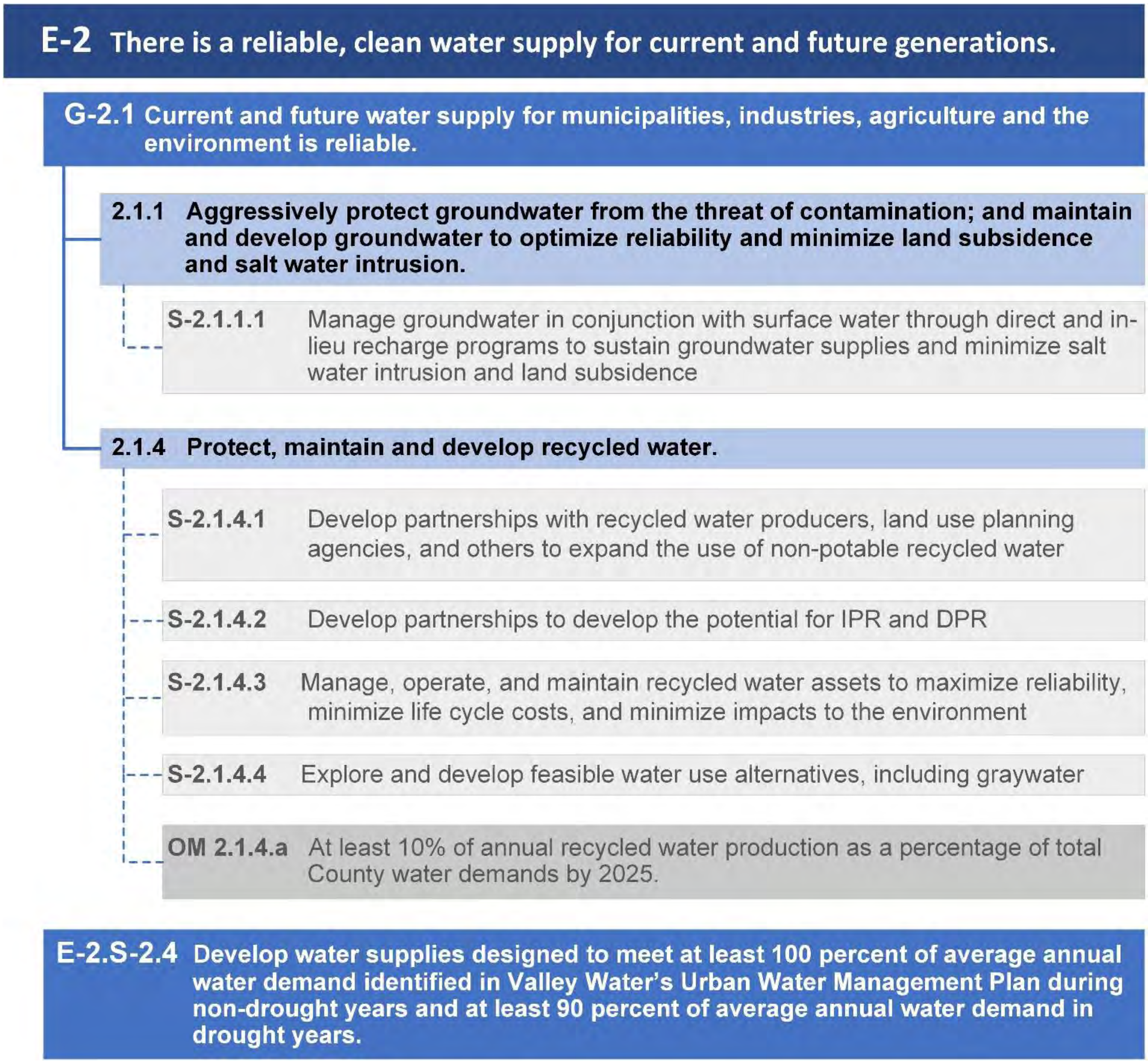


Figure 2-3. Framework of Valley Water Ends Policies: Board decisions through implementation by Valley Water staff

Recycled water objectives and strategies fall under Valley Water Board's Ends Policy E-2 (Figure 2-4). This policy pertains to overall water supply operations and requires that "there is a reliable, clean water supply for current and future generations." Further, the policy establishes an objective to "protect, maintain and develop recycled water." Several strategies were established to help meet this objective, along with an outcome measure: to sustain at least 10 percent of annual recycled water production as a percentage of total county water demands by 2025. Valley Water also has objectives and strategies related to groundwater recharge programs, which relate to IPR.



E-2 There is a reliable, clean water supply for current and future generations.

- **G-2.1** Current and future water supply for municipalities, industries, agriculture and the environment is reliable.
  - **2.1.1** Aggressively protect groundwater from the threat of contamination; and maintain and develop groundwater to optimize reliability and minimize land subsidence and salt water intrusion.
    - **S-2.1.1.1** Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and minimize salt water intrusion and land subsidence
  - **2.1.4** Protect, maintain and develop recycled water.
    - **S-2.1.4.1** Develop partnerships with recycled water producers, land use planning agencies, and others to expand the use of non-potable recycled water
    - **S-2.1.4.2** Develop partnerships to develop the potential for IPR and DPR
    - **S-2.1.4.3** Manage, operate, and maintain recycled water assets to maximize reliability, minimize life cycle costs, and minimize impacts to the environment
    - **S-2.1.4.4** Explore and develop feasible water use alternatives, including graywater
    - **OM 2.1.4.a** At least 10% of annual recycled water production as a percentage of total County water demands by 2025.

E-2.S-2.4 Develop water supplies designed to meet at least 100 percent of average annual water demand identified in Valley Water's Urban Water Management Plan during non-drought years and at least 90 percent of average annual water demand in drought years.

Figure 2-4. Valley Water Ends policy, goal, objectives, strategies, and outcome measures related to water reuse

The latest revision for E-2 and related goals and objectives occurred on August 20, 2012.

The latest BAO interpretations (strategies and outcome measures) for E-2 occurred on April 2, 2019.

2.1.4 Existing Plans

To support its goals and strategies, Valley Water and its regional partners develop planning documents that guide countywide water supply development, including:

- Water Supply Master Plan 2040 (2019; reviewed annually)
- Groundwater Management Plan (2016; updated every five years)
- 2015 Urban Water Management Plan (finalized in 2016)
- NPR planning: Partner Agencies' individual recycled water master plans
- PR planning, including Expedited Purified Water Program Plan (2018) and ROCM Plan (2019)

2.1.4.1 Groundwater Management Plan

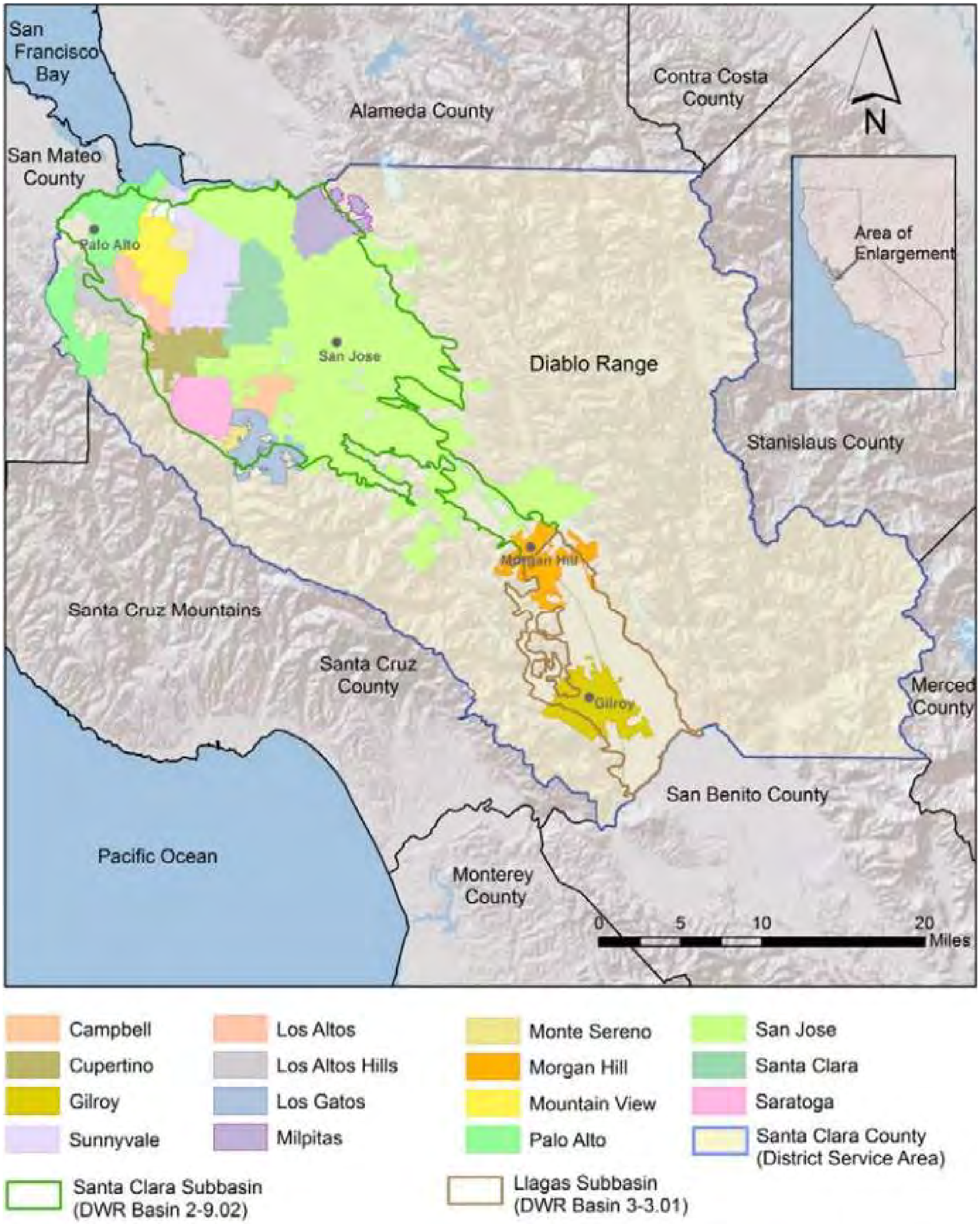
Santa Clara County includes portions of two groundwater basins as defined by the California Department of Water Resources (DWR): the Santa Clara Valley Basin and the Gilroy-Hollister Valley Basin. The two primary subbasins managed by Valley Water are the Santa Clara Subbasin and the Llagas Subbasin (Figure 2-5). As part of Valley Water's Groundwater Management Plan, two basin management objectives were established:

- Manage groundwater supplies to optimize water supply reliability and minimize land subsidence.
- Protect groundwater from existing and potential contamination.

Strategies to achieve these objectives include:

- Managing groundwater in conjunction with surface water through direct and in-lieu recharge programs.
- Implementing programs to protect or promote groundwater quality to support beneficial uses.
- Maintaining and developing adequate groundwater models and monitoring systems.
- Working with regulatory and land use agencies to protect recharge areas, promote natural recharge, and prevent groundwater contamination.

Thus, Valley Water can optimize the role of water reuse in supplementing the local water supply and managing the groundwater subbasins through a combination of direct replenishment (e.g., purified recycled water via IPR) and in-lieu recharge to reduce groundwater pumping via DPR (to supplement a water treatment plant) and NPR. In addition, reuse can help optimize water supply and provide Valley Water greater flexibility in water transfers. By recharging the groundwater subbasins with purified water in lieu of imported water, Valley Water could offset its imported water supplies.



Source: Valley Water, "Groundwater Management Plan." 2016

Figure 2-5. Santa Clara and Llagas Subbasins

2.1.4.2 Urban Water Management Plan and Water Shortage Contingency Plan

Valley Water's 2015 Urban Water Management Plan (UWMP) projects continued business and population growth and identifies a need to develop reliable local water supplies, including recycled water. It summarizes the county's current and projected PR and NPR water demands up to 2040, including local agency NPR systems. In 2015, NPR composed about 5 percent (or about 20,000 acre-feet per year [AFY]) of the county's supply.

As part of the UWMP, Valley Water's Water Shortage Contingency Plan (WSCP) defines its drought triggers and response actions. As noted in the WSCP, Valley Water maximizes storage of wet period supplies for use during dry periods when other sources of supply are insufficient to meet demands. Also as noted, Valley Water coordinates drought response actions closely with retailers, cities, and the County to minimize water shortages and hardships to communities, establish water use reduction targets, and maintain and safeguard essential water supplies for public health and safety needs.

2.1.4.3 Integrated Regional Water Management

Valley Water participates in two integrated regional water management (IRWM) efforts: the San Francisco Bay (SFB) Area IRWM and the Pajaro River Watershed IRWM.

The SFB Area IRWM, last updated in October 2019, describes water management goals, strategies, and projects within nine SFB Area counties, including Santa Clara. The SFB Area IRWM covers the following four functional areas:

- Water supply and water quality
- Wastewater and recycled water
- Flood protection and stormwater management
- Watershed management and habitat protection and restoration

The 2019 SFB Area IRWM brings together existing countywide and local plans and describes Valley Water's existing efforts to expand recycled water use.

The Pajaro River Watershed IRWM, last updated in October 2019, was developed collaboratively by the Pajaro Valley Water Management Agency, the San Benito County Water District, and Valley Water. It lays out goals for the watershed, strategies for its management, and potential upcoming projects. It refers to the 2004 South County Recycled Water Master Plan and 2015 Master Plan update for recycled water use projections (3,700 AFY by 2021).

2.1.4.4 Water Supply Master Plan 2040

Valley Water lays out a vision for meeting future water demands through 2040 in its Water Supply Master Plan 2040 (Valley Water, 2019) and includes recycled water projections for the county through 2040. Valley Water's 2019 Water Supply Master Plan identifies a need for 24,000 AFY of reuse supply, in addition to the UWMP's projected 33,000 AFY supply of NPR, to meet county water supply demands by 2040. This combined total of 57,000 AFY reuse water is expected to exceed Valley Water's minimum goal of 10 percent recycled water within the county.

2.1.4.5 NPR Planning: Partner Agencies' Individual Recycled Water Master Plans

Past reuse planning in the county has been focused on each of the four NPR systems (referred to as the "Partner Agencies") on an individual basis. The following studies establish a foundation for NPR planning relative to each system:

- PA/MV RWS
  - City of Palo Alto Recycled Water Facility Plan, prepared by the City of Palo Alto (December 2008)
  - City of Mountain View Recycled Water Facility Plan, City of Mountain View (March 2014)
  - Advanced Water Purification System Feasibility Study (May 2017)
  - Northwest County Recycled Water Strategic Plan (July 2019)
- SBWR
  - South Bay Water Recycling Strategic and Master Planning, prepared by the SBWR and Valley Water (December 2014)
- SJWC
  - San José Recycled Water Master Plan, San Jose Water Company, 2009 and updated in January 2011
- South County Recycled Wastewater Authority (SCRWA)
  - 2015 South County Recycled Water Master Plan Update, prepared by Valley Water and SCRWA in collaboration with the cities of Gilroy and Morgan Hill (May 2016)
  - Sustainable Water Management Planning, City of Gilroy and City of Morgan Hill (September 2019)
- Sunnyvale
  - City of Sunnyvale Feasibility Study for Recycled Water Expansion Report, City of Sunnyvale (June 2013)

2.1.4.6 PR Studies and Program Plan

Though IPR and DPR have not yet been implemented in the county, the need and opportunities for PR are captured by various planning studies. Valley Water's 2012 Water Supply and Infrastructure Master Plan set the initial framework for potential IPR and DPR opportunities. The 2014 SBWR Strategic and Master Planning Report built upon the 2012 Water Supply and Infrastructure Master Plan and identified potential pathways for up to 35,000 AFY of PR. Additionally, Valley Water has performed groundwater management studies to evaluate the feasibility of groundwater augmentation via IPR.

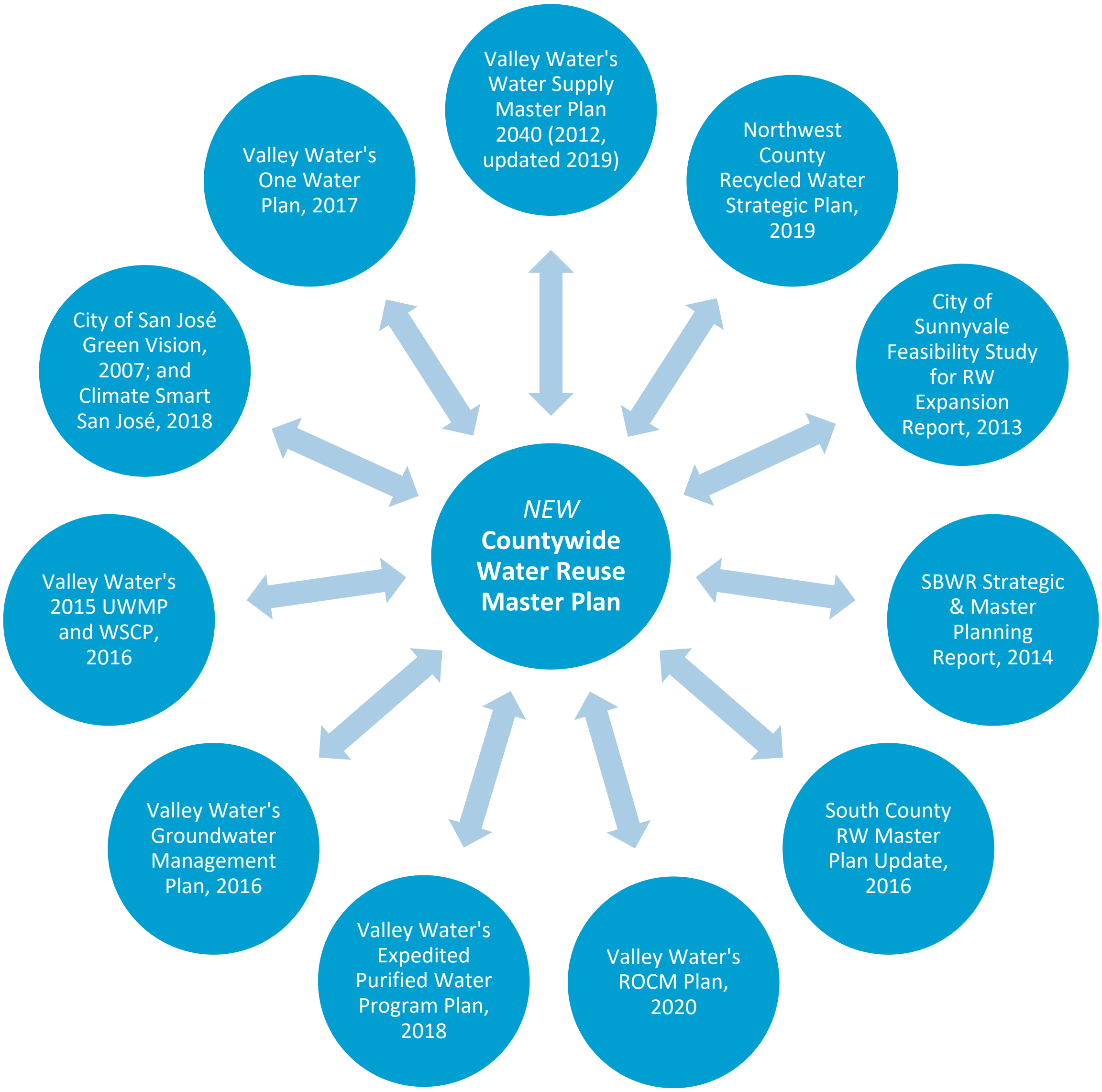
Valley Water's April 2018 Expedited Purified Water Program Plan assessed various PR project components, developed and evaluated project alternatives, and recommended an initial plan for implementation by 2025 that could provide up to 24,000 AFY of supply via advanced purification. Valley Water's water supply modeling indicated that providing up to 24,000 AFY of PR would complement other water supply sources to meet projected demands. The plan also identified future expansion options that could provide up to a total of 45,000 AFY of purified water, should it be needed to meet future water supplies. These options were further evaluated and incorporated into the Water Supply Master Plan 2040 released by Valley Water in late 2019.

The ROCM Plan is currently evaluating treatment alternatives for managing RO concentrate generated by the expansion of SVAWPC and other AWPF in the County. The plan is expected to be completed by mid-2020.

2.1.5 Master Plan

Valley Water initiated a process to integrate reuse planning and develop a comprehensive water reuse master plan for the County. The process began with stakeholder workshops in May 2016 and January 2017 to gain consensus on commitment to endorse regional planning for recycled and purified water, frame a vision, and identify key components for this Master Plan. Attendees included agency managers from local recycled water producers, wholesalers, and retailers, along with other public representatives (e.g., business interests and environmental non-governmental organizations).

This Master Plan will build on existing plans by integrating information and further evaluating the potential for collaboration (Figure 2-6). The Master Plan will identify how to optimize recycled and purified water supplies and infrastructure, improve sustainability and reliability of water reuse, expand NPR, develop PR, and integrate water reuse infrastructure in the county from a regional planning perspective.


Valley Water's Water Supply Master Plan 2040 (2012, updated 2019)
Valley Water's One Water Plan, 2017
Northwest County Recycled Water Strategic Plan, 2019
City of San José Green Vision, 2007; and Climate Smart San José, 2018
City of Sunnyvale Feasibility Study for RW Expansion Report, 2013
NEW Countywide Water Reuse Master Plan
Valley Water's 2015 UWMP and WSCP, 2016
SBWR Strategic & Master Planning Report, 2014
Valley Water's Groundwater Management Plan, 2016
South County RW Master Plan Update, 2016
Valley Water's Expedited Purified Water Program Plan, 2018
Valley Water's ROCM Plan, 2020

RW = recycled water

Figure 2-6. Master Plan integration of relevant Valley Water and Partner Agency planning studies

A full list of the documents referenced on Figure 2-6 is summarized in Attachment A.

The Master Plan will evaluate NPR and PR pathways to achieve Valley Water's recycled water targets by 2040. For NPR, alternatives for infill, expansion to new service areas, and interties to connect existing systems will be considered. For PR, alternatives for IPR and DPR will be considered, as well as a strategy to leverage existing facilities (Figure 2-7).

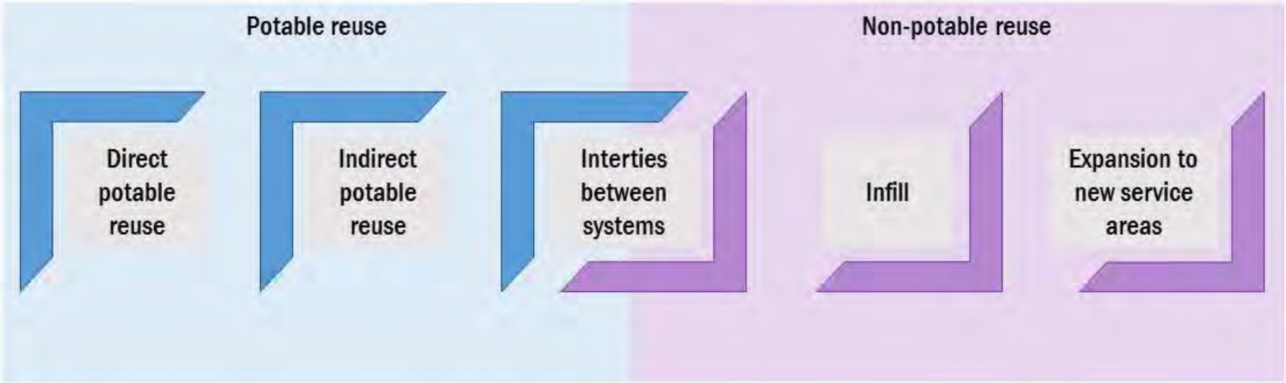
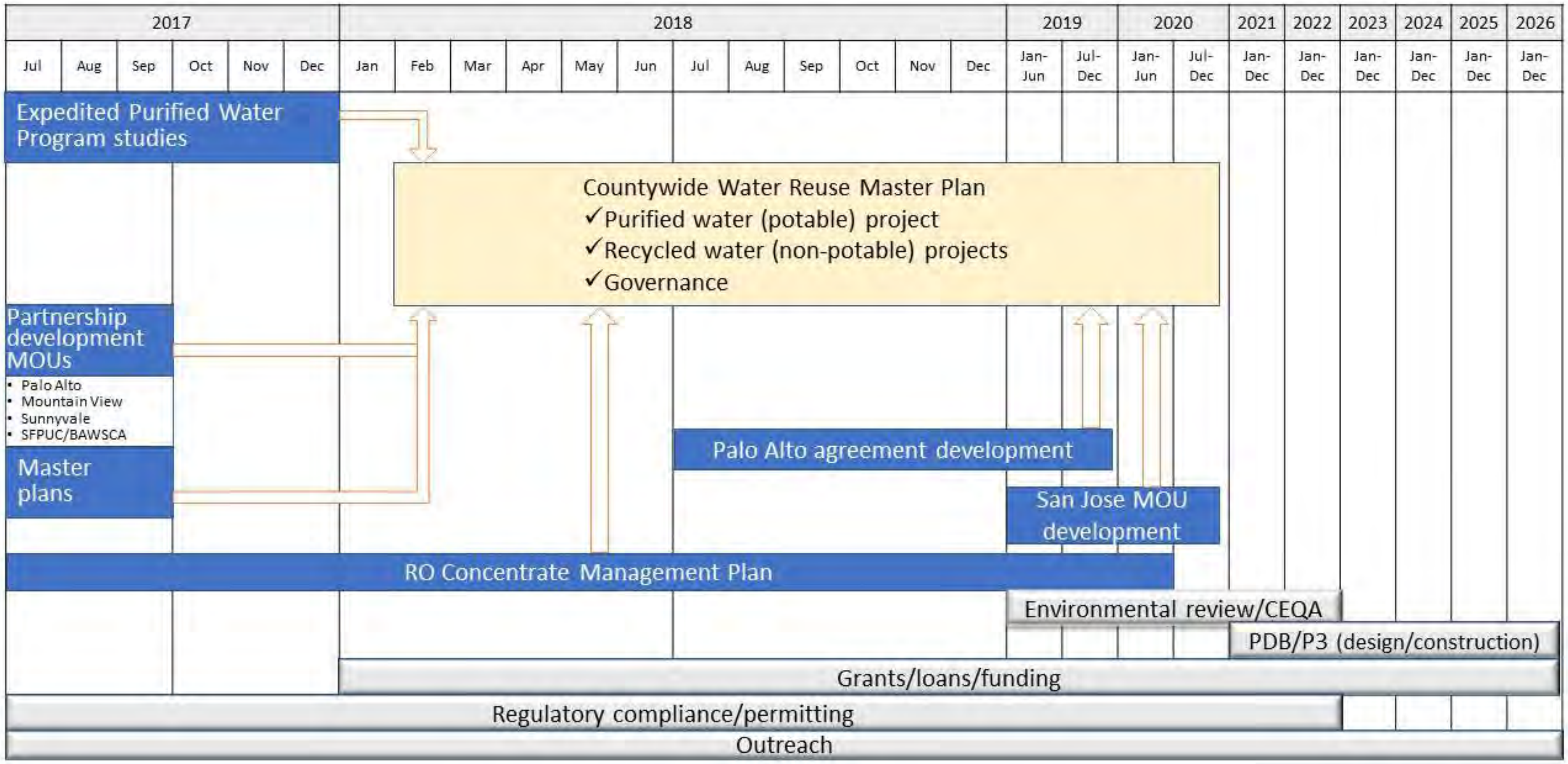


Figure 2-7. Recycled water pathways

The Master Plan will guide strategic investments in NPR and PR for both the near term (10 to 15 years) and long term (20+ years). The projected timeline for all work related to the Master Plan as of mid-2018 is shown on Figure 2-8.



BAWSCA = Bay Area Water Supply and Conservation Agency

SFPUC = San Francisco Public Utilities Commission

PDB = Progressive Design Build

Figure 2-8. Water reuse program timeline as of April 2018

2.2 Study Area and Water Resources

To achieve the countywide reuse vision, partnerships with recycled water producers (i.e., the four existing NPR systems and SVAWPC), wholesalers, and retailers are necessary (Figure 2-9). The recycled and purified water produced at these facilities is then distributed either by a wholesaler to retailers, or directly by retailers to end users (Figure 2-10).

The **Palo Alto Regional Water Quality Control Plant (RWQCP)** receives wastewater flows from Palo Alto, East Palo Alto Sanitary District, Stanford University, Los Altos, Los Altos Hills, and Mountain View. RWQCP produces recycled water and distributes it in Palo Alto on a retail basis, and sells it to the City of Mountain View on a wholesale basis for distribution in Mountain View city limits. In 2015, RWQCP produced 1,268 acre-feet (AF) of recycled water, including utility flows.

The **San José/Santa Clara RWF** receives wastewater flows from the City of San José (co-owner of RWF), City of Santa Clara (co-owner of RWF), Milpitas, Cupertino, Los Gatos, Saratoga, Monte Sereno, and County Sanitation District 2-3 (Tributary Agencies). In the 1990s, the City of San José and Valley Water collaborated on planning the SBWR system, driven by the RWF's National Pollutant Discharge Elimination System (NPDES) permit effluent limitations and projected population growth. SBWR is the recycled water producer and wholesaler while the City of Milpitas, City of Santa Clara, San José Municipal Water System, and San José Water Company are retailers. Additionally, the Silver Creek Pipeline Agreement allows Valley Water to serve as wholesaler for 5 mgd of SBWR water within a dedicated service area. In 2015, the SJ/SC RWF produced nearly 10,000 AF of recycled water.

Under Partnership Agreements entered in 2010 between the City of San José and Valley Water, SVAWPC was constructed and began operations in 2014. The purified water produced at SVAWPC is blended with the RWF's NPR recycled water to improve the water quality and reduce TDS within the SBWR system. In 2015, SVAWPC produced more than 5,000 AF of purified water.

SCRWA receives wastewater flows from Gilroy and Morgan Hill and sends tertiary treated effluent to the South County RWS for use by the City of Gilroy. SCRWA is the recycled water producer, Valley Water is the wholesaler, and the City of Gilroy is the retailer. In 2015, SCRWA produced about 2,100 AF of recycled water, including utility flows.

Sunnyvale Water Pollution Control Plant (WPCP) receives flows from the City of Sunnyvale and sends tertiary treated effluent to the Sunnyvale RWS for retail in Sunnyvale. For the recently constructed 2.5-mile-long Wolfe Road Pipeline, Sunnyvale is the producer and retailer of recycled water for most of the City recycled water distribution system. Valley Water wholesales recycled water to the California Water Service Company to retail along the Wolfe Road recycled water pipeline. This pipeline was designed to serve customers south of the San Lucar Pump Station and within Cupertino. In 2015, Sunnyvale WPCP produced approximately 3,100 AF of recycled water, including utility flows.

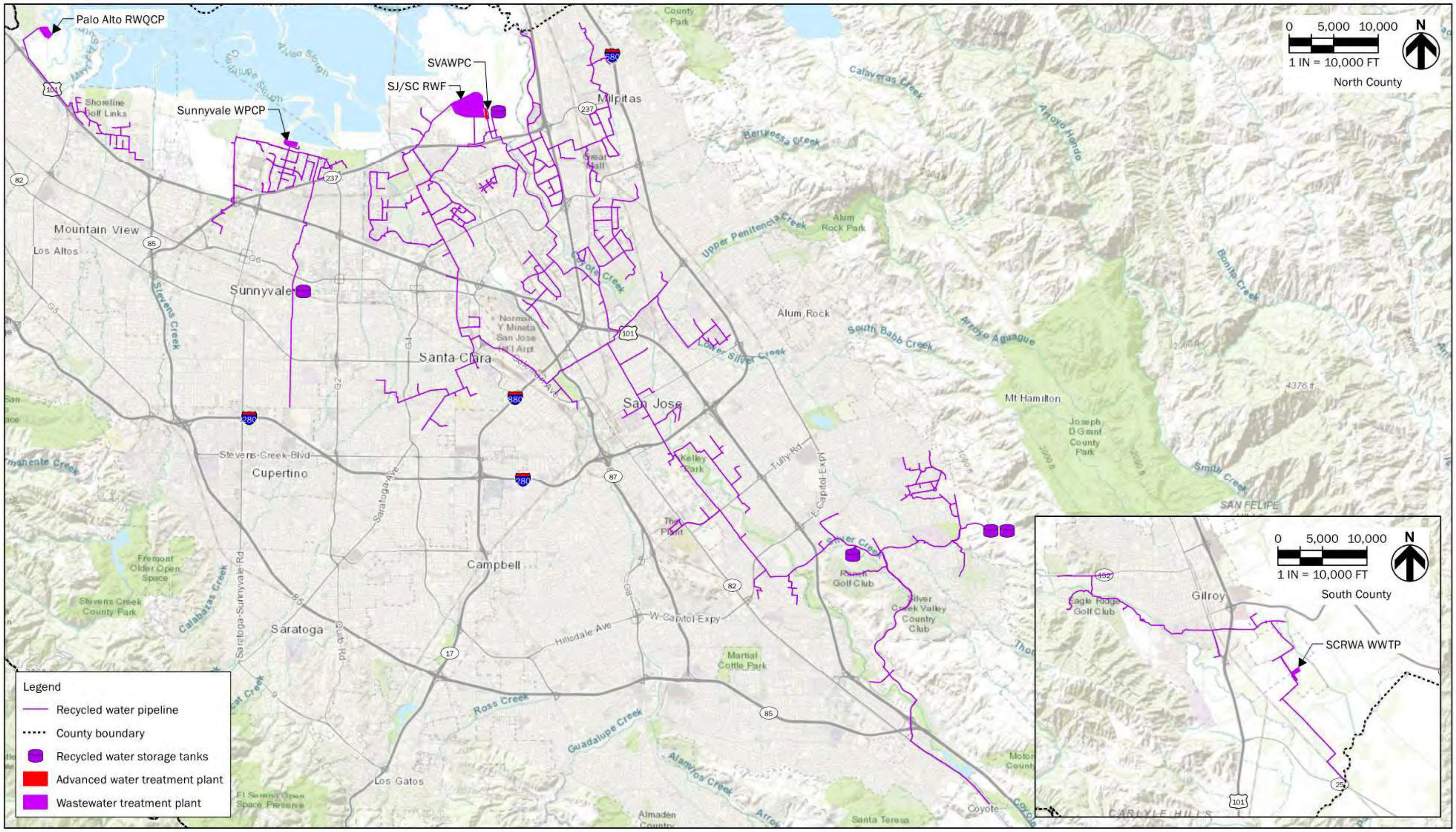


Figure 2-9. Study area and existing recycled water systems

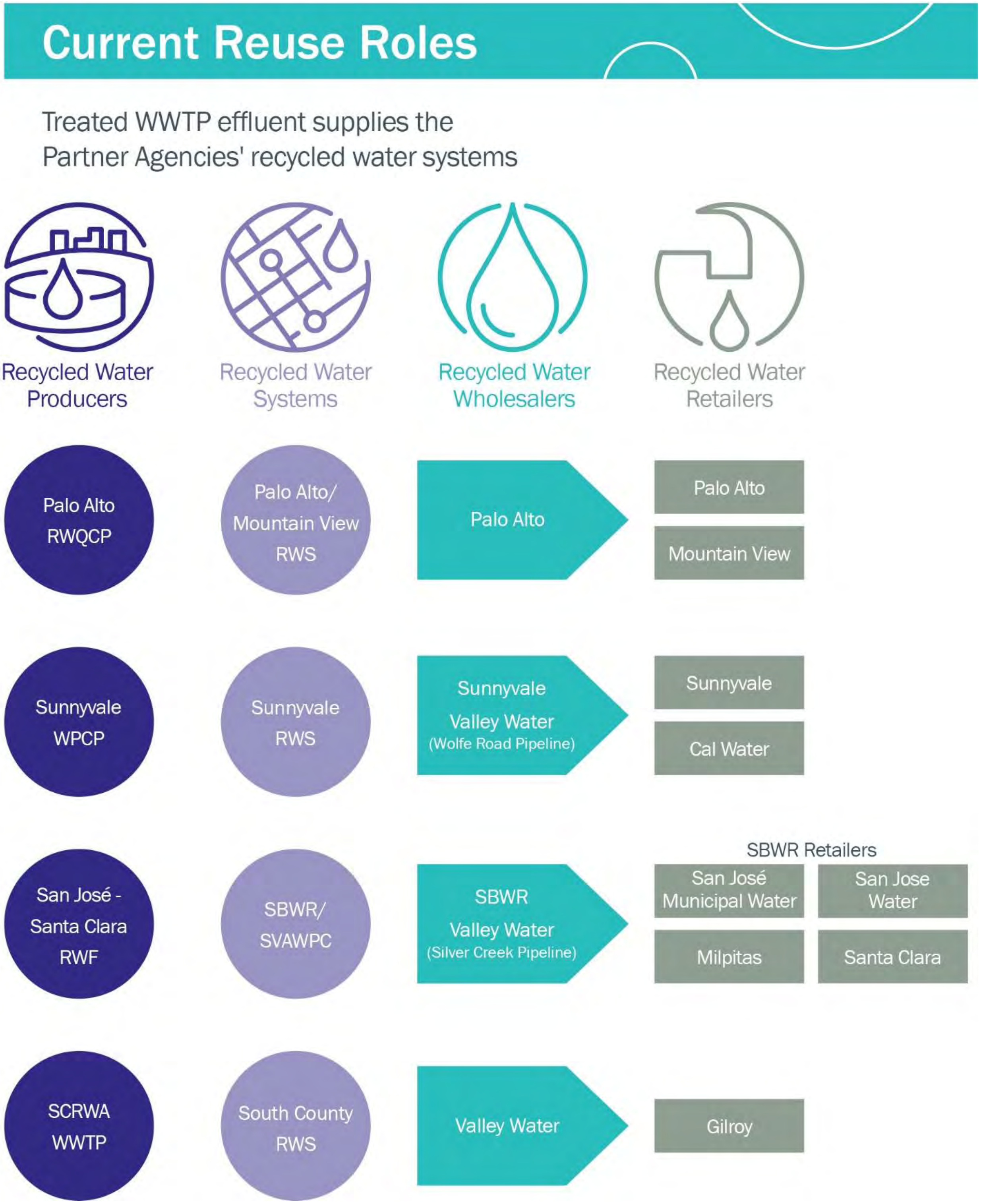


Figure 2-10. Existing Santa Clara County recycled and purified water suppliers

Section 3: Roles and Responsibilities

Valley Water's collaboration with the Partner Agencies is critical to expanding Countywide water reuse. Current and future agreements outline each agency's roles and responsibilities, described below.

3.1 Valley Water Roles and Responsibilities

Valley Water is governed by a seven-member Board of Directors comprising elected representatives from seven geographical districts in the county who serve overlapping 4-year terms. The Board directs Valley Water's CEO, who oversees the work of Valley Water staff. Valley Water's roles and responsibilities are shaped primarily by California state law (i.e., the District Act) along with various Valley Water policies and institutional agreements with other parties. Additionally, Valley Water is considered an independent "special district" (i.e., "any agency of the state for the local performance of governmental or proprietary functions within limited boundaries").[1] These agencies derive their authority from separate generic statutes that apply to all special districts of that type (e.g., municipal water districts). They are formed by the Local Agency Formation Commission and require voter approval in the geographic area influenced by fees and services. Special districts are governed by elected boards and provide only services allowed by state law.

Today, Valley Water's roles include water supply, flood protection, and stream stewardship. Table 3-1 summarizes Valley Water's roles that relate to water reuse and associated responsibilities.

Table 3-1. Valley Water Roles and Responsibilities Pertaining to Water Reuse

Role	Valley Water's Responsibility
Regional leadership	Engages in regional water supply planning and coordinates with regional partners.
Water retailer assistance	Meets regularly with the local water retailers to provide information, offer technical support, and help develop regional alliances. There are currently 13 major water retailers in Santa Clara County.
Water conservation programs leader	Leads water conservation efforts with innovative, effective, and comprehensive-in-scope programs.
Local surface water leader	Operates and maintains 20 appropriative water rights licenses and one filed water right permit with the State Water Resources Control Board totaling more than 227,300 AFY.
Ensure sustainability leadership	Develops strategies to secure and optimize the use of existing water supplies and infrastructure and to expand water recycling and long-term water conservation savings. Valley Water is also working with seven local water agencies to optimize the sharing of water resources regionally, known as Bay Area Regional Reliability (BARR).
ROCM leader	Leads workshops with stakeholders in a collaborative process to develop ROCM solutions, in addition to conducting pilot-scale testing of treatment alternatives.
Groundwater management	Leads groundwater management efforts for Santa Clara County through comprehensive programs and investments, including storage of surface water in groundwater basins and in-lieu recharge to help balance pumping and provide reserves for use during dry years.

To meet the objective of purified water development within the county, partnerships and collaborations among recycled water producers, wholesalers, retailers, users, and other interested parties are necessary. Current relationships exist between Valley Water and the Partner Agencies operating the County's four NPR systems (PA/MV RWS, SBWR, SCRWA, Sunnyvale RWS), along with other stakeholders. The Master Plan will guide continuing collaborations and future potential partnerships.

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[1] Government Code §16271 [d]

3.2 Regulatory Responsibilities

Valley Water, its Partner Agencies, and other retailers in the area have varying regulatory responsibilities. NPR producers are responsible for meeting Title 22 requirements, complying with Water Reclamation Orders, and ensuring discharges from facilities meet NPDES permit quality requirements. NPR retailers must enforce Title 22 Use Area Requirements by monitoring recycled water customers/users. PR producers are responsible for meeting more stringent quality requirements, depending on direct or indirect application. PR wholesalers and retailers do not share regulatory responsibilities. Descriptions of regulations, including specific regulatory requirements for potable reuse, are included in the Regulations Framework TM (Appendix B-2).

3.3 Past and Current Reuse Partnerships

Valley Water has executed agreements and memorandums of understanding (MOU) related to reuse with external partners, including Partner Agencies and private companies, as summarized in Attachment B (organized by Partner Agency service areas and chronological order) and described in further detail in the following subsections. While some of these agreements have common traits (characterized as the “type” of agreement in this TM), they vary in terms of subject, cost to each party, and recycled water transfer opportunity.

Valley Water’s agreements to date with the PA/MV RWS relate to:

- Cost-sharing and flow commitments related to constructing, managing, and operating a salinity removal facility (called the Local Plant) to produce 1.25 mgd of enhanced recycled water for the RWQCP service area, and an AWPF (called the Regional Plant) capable of treating effluent flows of 9 mgd or greater to benefit the regional water supply .
- Joint planning or feasibility studies to examine water reuse alternatives (WRA).

Agreements between Valley Water and the City of San José/SBWR fall into three general categories:

- Cost-sharing for the development/expansion and use of SBWR
- Cost-sharing for managing and operating the Silver Creek pipeline
- Cost-sharing and flow commitments related to constructing, managing, and operating SVAWPC

Valley Water’s agreements with SCRWA fall into two categories:

- Defining the producer-wholesaler relationship, including roles/responsibilities, costs/prices, and flows (with prices and flows negotiated annually)
- Cost-sharing related to new pipeline construction and operation

Agreements between Valley Water and Sunnyvale fall into two categories:

- Cost-sharing and/or flow commitments for the new Wolfe Road pipeline
- Cost sharing and responsibilities for joint feasibility studies to examine WRAs

3.3.1 Palo Alto/Mountain View Recycled Water System

Recycled water collaboration between Palo Alto and Valley Water dates back to the 1970s. In March 2014, Valley Water and Palo Alto initiated policy-level discussions on recycled water that resulted in the May 2014 formation of the Joint Recycled Water Committee (JRWC).

In May 2016, Valley Water, Palo Alto, and Mountain View partnered to share consultant support costs related to development of the “Advanced Water Purification System Feasibility Study” published in May 2017. The feasibility study evaluates treatment technologies, concentrate management, permitting, costs, and schedule for constructing an AWPF to be used for enhancing the quality of PA/MV’s RWS supply to create NPR+ supply. The study recommends phased implementation of the NPR+ AWPF, starting with a 1.125-mgd Phase 1 facility located at the RWQCP, increasing to 2.25 mgd capacity as part of Phase 2. Phase 3 involves constructing a 4.5-mgd facility at a nearby site that requires voter support to allow use of the land.

In December 2016, Valley Water, Palo Alto, and Mountain View agreed to share consultant support costs in revising RWQCP's 1992 Water Reclamation Master Plan to create the Northwest County Recycled Water Strategic Plan (Strategic Plan), finalized in March 2020. The Strategic Plan includes evaluating:

- NPR expansion opportunities within the RWQCP service area and additional portions of East Palo Alto and Menlo Park not served by the East Palo Alto Sanitary District. The highest-ranked NPR option involves expanding the PA/MV RWS to the Stanford Research Park area along Page Mill Road and then to Purissima Park, Fremont Hills Country Club, Palo Alto Hills Country Club, and Foothills Park.
- Palo Alto-based IPR opportunities, such as an alternative involving injection of approximately 2,800 AFY into wells located in Palo Alto's Downtown and Professorville neighborhoods, and installation of new groundwater supply wells to supplement existing imported potable supply.
- Palo Alto-based DPR opportunities, such as an alternative involving construction of a new DPR AWPF located near the RWQCP, 4.75 million gallons of engineered storage, and pipelines to connect the storage tank to three separate points in Palo Alto's potable water distribution system.

In August 2017, Valley Water and Palo Alto signed an MOU to affirm the parties' commitments to study the feasibility of WRAs. including:

- A Valley Water-constructed and -owned AWPF in Palo Alto
- Water recharge and reuse alternatives identified in the Strategic Plan
- Future development and governance of Palo Alto's NPR system

The MOU also states that Valley Water will evaluate opportunities for Palo Alto to transfer up to 10 mgd of effluent to Valley Water. RO concentrate will be the responsibility of Valley Water, although the City of Palo Alto agrees to work with Valley Water on RO concentrate management. In addition, Palo Alto will help Valley Water identify and permit land for constructing a future AWPF. In October 2017, Valley Water and Mountain View signed a similar MOU to affirm the parties' commitments to study the feasibility of water reuse alternatives.

In December 2019, Palo Alto, Mountain View, and Valley Water executed a long-term agreement to replace the 2017 MOU that ensures Valley Water a minimum of 9 mgd of source water supply for regional potable reuse over 75 years. The agreement also defines a plan for Valley Water to provide $16 million toward the construction of an AWPF to enhance recycled water quality operated by Palo Alto.

3.3.2 South Bay Water Recycling System

The San José/Santa Clara RWF is governed by the Treatment Plant Advisory Committee (TPAC) and the City of San José Council. TPAC consists of representatives from the co-owners and Tributary Agencies. These organizations make policy and budget decisions related to SBWR to prioritize the interests and needs of the facility and the sanitary sewer ratepayers of San José, Santa Clara, and the Tributary Agencies. The City of San José serves as the Administrative Agency for the RWF and SBWR. San José and Valley Water have a long history of recycled water collaboration and partnerships on SBWR financing and funding pursuits. Collaborative efforts date back to the early 1990s. The first major agreement between Valley Water and City of San José was the April 1998 cost-sharing agreement for development and use of SBWR.

The SBWR Collaborative was initiated in 2002 and led to past long-term agreements that guided RWF and Valley Water collaboration. The SBWR Collaborative established objectives relevant to the ownership of the SBWR system and concluded that:

- It is advantageous for the RWF and Valley Water to work together to maximize recycled water beneficial uses.
- Enhancing the quality of recycled water is key to increasing beneficial uses.
- A long-term agreement between the RWF and Valley Water was needed.

The following sections describe current collaborations between Valley Water and the City of San José in detail.

3.3.2.1 SBWR Expansion and Silver Creek Pipeline

In 2002, Valley Water and City of San José entered into a 25-year agreement to develop an institutional framework for long-term ownership, operation, maintenance, and future expansion of SBWR and cost-sharing to develop the Silver Creek Pipeline. Per the agreement, the City owns the pipeline and acts as wholesaler for recycled water to be delivered to the Metcalf Energy Center and other end users within the Evergreen and Edenvale service areas by the San José Municipal Water System. Valley Water has rights to 5 mgd of recycled water from the Silver Creek pipeline with the potential for more, depending on availability.

3.3.2.2 Integration Agreement and Ground Lease and Property Use Agreement

The 40-year Integration Agreement provides a framework for the City of San José and Valley Water to financially and administratively support SVAWPC and the cost-effective, environmentally beneficial production and use of recycled water in Santa Clara County consistent with each party’s separate and distinct interests: wastewater treatment and disposal for the City of San José, and water quality and supply for Valley Water. It specifies the formation of a Recycled Water Policy Advisory Committee (RWPAC) composed of elected officials from San José, Santa Clara, and Valley Water; the formation of Technical Working Groups comprising staff from the cities of San José and Santa Clara and Valley Water to advise the RWPAC; and the RWF’s contribution to advanced water purification and Valley Water’s contributions to SBWR operations. Additionally, the agreement states that prior to July 1, 2020, export of secondary treated wastewater or recycled water out of the county is not allowed by either party. After July 1, 2020, if demand for in-county use of recycled water is less than available supply, each party may engage in negotiations for out-of-county export of secondary treated wastewater or recycled water. The agreement expires in July 2050.

The 40-year Ground Lease and Property Use Agreement describes responsibilities for constructing and operating SVAWPC and related facilities on a portion of the WPCP premises. It also requires Valley Water to accept up to 12 mgd of secondary treated effluent, and operate and maintain SVAWPC to provide up to 8 mgd of purified water to blend with existing recycled water and produce blended recycled water with TDS levels of about 500 milligrams per liter (mg/L).

3.3.2.3 Operation and Maintenance Agreement for the SVAWPC

In December 2016, Valley Water and City of San José entered into a 34-year Operations and Maintenance Agreement for SVAWPC. The agreement defines roles and responsibilities and requires the RWF to accept 1.5 mgd of waste stream discharge and 2 mgd of RO concentrate. The agreement expires in June 2050 along with the Integration and Ground Lease and Property Use Agreements.

3.3.3 South County Recycled Water System

SCRWA’s recycled water system began operating in 1977, but operated intermittently because of demands and variabilities in recycled water quality up until the 1990s. In October 1999, Valley Water entered into a series of three 20-year producer-wholesaler agreements establishing SCRWA as the producer, Valley Water as wholesaler, and the City of Gilroy as retailer of recycled water. These agreements detail roles and responsibilities and establish cost-sharing for a master plan and capital improvement program (CIP). As part of the agreements, SCRWA may sell flows of recycled water that exceed the Annual Delivery Quantity (a mutually agreed-upon flow established each year) to other wholesalers/end users, and Valley Water may sell water to be used by end users outside of the producer's service area (with approval by SCRWA).

As a result of the 1999 agreements, the initial South County Recycled Water Master Plan, completed in late 2004, identified recycled water capital investment projects to improve the South County recycled water system's reliability and to expand the use of recycled water. Per the agreements, updated in 2006, the parties shall work together to update, at 5-year intervals, the Master Plan for the design and construction of expanded recycled water production and distribution facilities. The most recent Master Plan update occurred in 2016. In December 2010, Valley Water and SCRWA signed an MOU defining roles and responsibilities for constructing the South County Pipeline extension to the Pajaro River to deliver recycled water to agricultural customers during spring, summer, and fall. SCRWA will pay all costs for and own the pipeline extension, and Valley Water will pay for and own irrigation turnouts from the pipeline. Two additional agreements between Valley Water, the City of Gilroy, and private developers in February 2015 resulted in additional pipeline extensions. Private developers agreed to pay for the design and construction of pipelines, while Valley Water contributed funds to increase the size of pipelines beyond the developments' required capacities. Valley Water will assume ownership of both pipelines when construction is complete.

In July 2011, Valley Water agreed to transfer ownership of three recycled water meters to the City of Gilroy in exchange for Gilroy reporting water usage data to Valley Water.

3.3.4 Sunnyvale Recycled Water System

In December 2014, Valley Water and the City of Sunnyvale established a funding agreement to evaluate alternative plant layouts and facilities for the Sunnyvale WPCP with the goal of increasing electrical capacity and developing a potential AWPF that was conceptually evaluated at the time. In August 2016, the City of Sunnyvale adopted a WPCP Master Plan update with the goal of upgrading wastewater treatment systems through 2035 to produce suitable water for advanced purification. Valley Water agreed to work with the City of Sunnyvale to develop a site plan to be included in the WPCP Master Plan.

In fall 2013, Valley Water and Sunnyvale agreed to cost-share design of the Wolfe Road Pipeline. Subsequently, in early 2015, Valley Water, Sunnyvale, Apple Inc., and Cal Water agreed to cost-share the construction of the Wolfe Road Pipeline. Per the Recycled Water Supply/Distribution Agreement, Sunnyvale (producer) shall supply Valley Water (wholesaler) with recycled water to distribute to retailers from the Wolfe Road Pipeline and Sunnyvale will operate and maintain the pipeline (to be reimbursed by Valley Water). Additionally, Sunnyvale shall make available to Valley Water at least 500 AFY of recycled water for distribution outside the city and 595 AFY of recycled water for distribution within the city. Valley Water will make available for purchase by Sunnyvale at least 595 AF of recycled water for delivery to Sunnyvale's end users. Recycled water conveyed through the Wolfe Road Pipeline is owned by Valley Water and may be resold to Valley Water's other customers, including water retailers, regardless of whether their service areas are located within or outside Sunnyvale's service area.

In May 2016, Valley Water and Sunnyvale agreed to receive State Grant funds, administered by the Association of Bay Area Governments (ABAG) in partnership with the San Francisco Estuary Partnership (SFEP), of up to $4 million for the Sunnyvale Continuous Recycled Water Production Facilities and Wolfe Road Pipeline project. $1.5 million was to reimburse the City of Sunnyvale for the Continuous Recycled Water Production Facilities and $2.5 million to reimburse Valley Water for the Wolfe Road Pipeline project. The grant required $6 million in matching funds from Valley Water.

In June 2017, Valley Water and Sunnyvale signed an MOU agreeing to study the feasibility of WRAs. As part of the MOU, the parties identified three alternative plant layouts and facilities for the Sunnyvale WPCP upgrade. Two options involve an AWPF constructed by Valley Water on the Sunnyvale WPCP site, and the other involves an AWPF close to the WPCP site. Sunnyvale will help evaluate other options, including interties, a small-scale AWPF, and a pipeline to SVAWPC.

The MOU also states that Valley Water will evaluate opportunities for Sunnyvale to transfer up to 5 mgd of effluent from the Sunnyvale WPCP dual-media filters through 2020, and an additional 5 mgd of this effluent after 2020. Valley Water and Sunnyvale will develop a residuals management plan if any alternatives are implemented. The MOU states an assumption that Valley Water will be responsible for RO concentrate from a Valley Water-owned AWPF, and Sunnyvale will be responsible for salinity management of any NPR-related projects.

3.3.5 Other Agreements

This section describes other agreements outside of those affecting the Partner Agencies.

3.3.5.1 SFPUC/BAWSCA

Valley Water works with the San Francisco Public Utilities Commission (SFPUC) and the Bay Area Water Supply and Conservation Agency (BAWSCA) on regional water management. Several BAWSCA member agencies receive water from both Valley Water and SFPUC. In addition, Valley Water, SFPUC, and BAWSCA collaborate on the SFB IRWM and BARR.

In March 2017, Valley Water, SFPUC, and BAWSCA signed an agreement to cost-share consultant support services to evaluate alternatives for SFPUC/BAWSCA participation in Valley Water’s Expedited Purified Water Program, as Valley Water may develop capacity to produce additional water supplies that could be available to SFPUC, BAWSCA, and common customers.

3.3.5.2 Cinnabar Hills Golf Club

In October 2014, Valley Water entered into a cost-sharing agreement with Cinnabar Hills Golf Club (Cinnabar) in which Cinnabar leadership agreed to contribute funding toward recycled water development, which may directly or indirectly benefit Cinnabar by providing an alternative water source supply. In 2017, Valley Water prepared a preliminary feasibility analysis to size pumps and pipelines to potentially deliver recycled water to Cinnabar.

3.4 Considerations for Future Agreements

Each of the Partner Agencies has specific considerations/barriers that must be addressed to advance reuse and achieve the Project vision, as summarized by agency in Table 3-2. The nature of the considerations/ barriers spans a fairly broad range, from concerns about potential rate impacts as expressed by elected officials on behalf of their constituents to potential logistical and institutional barriers. In addition, the degree to which each consideration/barrier may affect agencies may vary considerably.

Table 3-2. Critical Path Considerations for Partnerships with Recycled Water Producers

Consideration/Barrier	Palo Alto RWQCP	San José/ Santa Clara RWF	Sunnyvale WPCP	SCRWA
1. Impacts to water and/or sewer rates resulting from reuse agreements and projects	✓	✓	✓	✓
2. Economic growth/development enabled by resulting supplies	✓	✓	✓	✓
3. Environmental demands/impacts resulting from changes in treated effluent flows to the San Francisco Bay	✓	✓	✓	
4. Effluent water quality (using existing treatment facilities) – Changes or degraded recycled water quality (e.g., due to saltwater intrusion in corroded distribution pipes), compromising the success of interties or other future collaborations between Partner Agencies and Valley Water.	✓	✓	✓	✓
5. RO concentrate management and NPDES permit compliance – A key consideration for future AWPF agreements.	✓	✓	✓	✓
7. Land use/property availability for new facilities	✓	✓	✓	
8. Bond financing – The SBWR system was partially funded by public bonds, and rules governing the sale of bond-funded assets to private entities are a consideration for and potential barrier to future agreements. SBWR bond and loan repayments will be complete in 2021. The bonds were series 2005A and 2009A issued by the San José-Santa Clara Clean Water Financing Authority ($54 million and $21.4 million, respectively) and a loan from the State Revolving Fund ($73.6 million).		✓		
9. Partner Agency barriers outside of Valley Water control – For example, SBWR has relationships with Tributary Agencies and Retailers that will affect the potential for future agreements between Valley Water and SBWR.	✓	✓		
10. Schedule – Sequencing implementation of capital improvement projects and aligning timelines across agencies.	✓	✓	✓	✓

3.5 Collaboration and Engagement

To develop and sustain a common vision for the region, robust engagement is needed across various interest groups and levels, including policymakers, Partner Agencies, stakeholders (external to Valley Water and Partner Agencies), industry experts, regulators, and the general public. All of these partners and stakeholders must work together to create a template for a new recycled water market within the county. Using a countywide market approach will enable agencies to enhance water supply reliability, leverage existing infrastructure investments, facilitate water transfers during critical shortages, and improve climate change resilience.

Moving forward, Valley Water's collaboration strategy will emphasize multiple levels of engagement (Figure 3-1), allowing staff, general managers, and stakeholders to be meaningfully engaged through scheduled meetings and strategic workshops to gain buy-in, generate support, and garner good will within the community. Meeting and workshop facilitation will start by empowering stakeholders with critical information to establish a clear, level baseline of working knowledge. This knowledge can then support productive group dialogue and decision making in many directly relevant and successful venues. Beyond large meetings and workshops, Valley Water will continue be involved with establishing partnerships and creating new institutional structures to support a common vision for the region. Proactively addressing governance issues will be a significant focus of the Master Plan, forging consensus among diverse stakeholders, documenting commitments, and articulating the vision in actionable master plans.

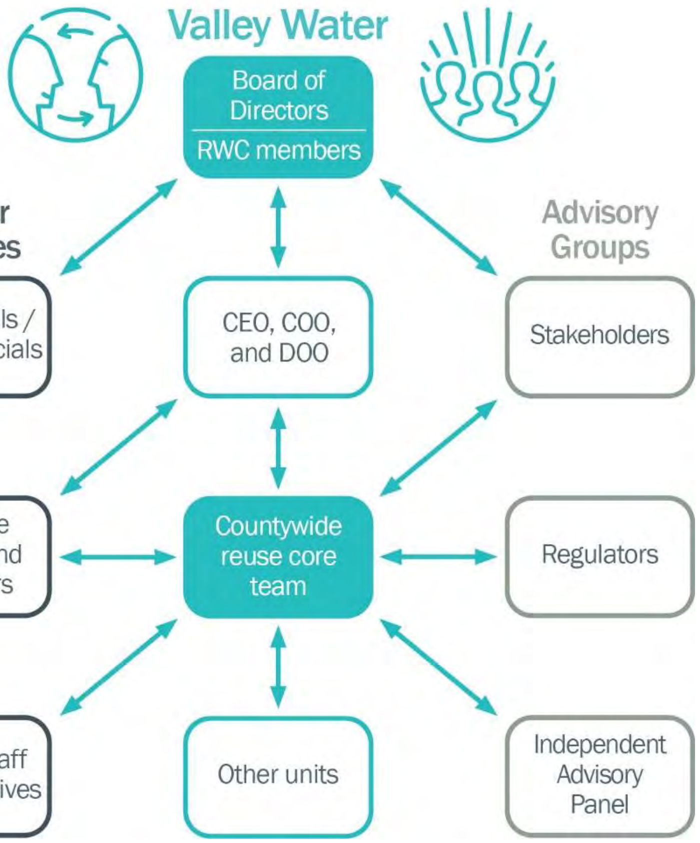
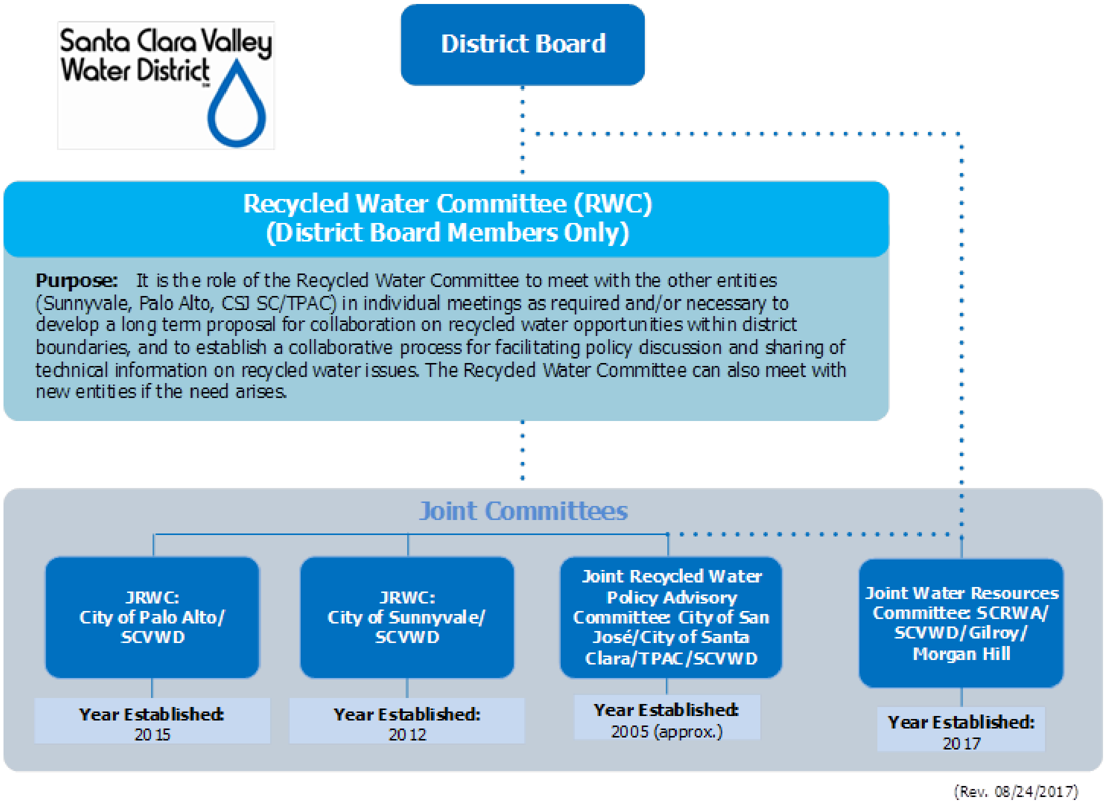

Valley Water
Board of Directors
RWC members
Partner Agencies
Advisory Groups
City Councils / elected officials
CEO, COO, and DOO
Stakeholders
Executive leaders and managers
Countywide reuse core team
Regulators
Primary staff representatives
Other units
Independent Advisory Panel

Figure 3-1. Levels of engagement to guide Master Plan development

3.5.1 Recycled Water Committees

Valley Water's Board formed a Recycled Water Committee (RWC), made up of three Board members, to facilitate collaboration among Valley Water and the four Partner Agencies. The RWC participates in three JWRCs as shown on Figure 3-2. A fourth JWRC is managed by Valley Water's full Board.



Santa Clara Valley Water District
District Board
Recycled Water Committee (RWC)
(District Board Members Only)
Joint Committees
JRWC: City of Palo Alto/ SCVWD
Year Established: 2015
JRWC: City of Sunnyvale/ SCVWD
Year Established: 2012
Joint Recycled Water Policy Advisory Committee: City of San José/City of Santa Clara/TPAC/SCVWD
Year Established: 2005 (approx.)
Joint Water Resources Committee: SCRWA/ SCVWD/Gilroy/ Morgan Hill
Year Established: 2017
(Rev. 08/24/2017)

Purpose: It is the role of the Recycled Water Committee to meet with the other entities (Sunnyvale, Palo Alto, CSJ SC/TPAC) in individual meetings as required and/or necessary to develop a long term proposal for collaboration on recycled water opportunities within district boundaries, and to establish a collaborative process for facilitating policy discussion and sharing of technical information on recycled water issues. The Recycled Water Committee can also meet with new entities if the need arises.

Figure 3-2. How Valley Water's Board and its recycled and purified water board committees interact

The Board JRWC members are elected officials who share technical information on recycled water issues and collaborate on policy decisions. They assist in developing and recommending policies to Valley Water Board and their respective city councils, as well as in providing high-level direction related to integrating and expanding recycled and purified water in the county.

The Master Plan is a recurring topic discussed at RWC and JRWC meetings. Periodic updates on the status of Master Plan development will be shared with the RWC/JRWCs to keep policymakers apprised of the progress and direction. In addition, many other topics regularly discussed during RWC meetings influence the Master Plan, and vice versa.

3.5.2 Partner Agencies

Valley Water is collaborating with the Partner Agencies at executive and staff levels to develop the Master Plan. During the outset of Master Plan development, Valley Water executives are holding individual (one-on-one) meetings with executives from individual Partner Agencies to understand their desired Project outcomes and explore a shared vision for advancing reuse countywide, before convening to meet as an ELG. The ELG is made up of the respective general manager, city manager, or public works director from each of the Partner Agencies, and its mission is to provide strategic input on the Project/partnerships' direction at key milestones and confirm partnership guiding principles.

After one-on-one executive meetings and before the first ELG meeting, Valley Water convened designated staff representatives from Valley Water and each Partner Agency for the first PPG meeting. Throughout development of the Master Plan, the PPG supported and informed technical Project aspects, represented their respective agency's interests, and provided continuity to past/ongoing work (studies, plans, projects, and programs).

Because the Project involves an update to the SBWR Recycled Water Master Plan, Valley Water held one-on-one meetings with SBWR retailers to review relevant information, assumptions, and early findings related to hydraulic scenarios, potential strategies, and prioritized actions to accommodate existing and future reuse demands.

3.5.3 Stakeholders

Valley Water formed a Stakeholder Task Force (TF) composed of representatives from agencies/ organizations external to the Partner Agencies to provide feedback through the Master Plan development, including interim work products and reuse alternatives. The TF process provides stakeholders an opportunity for substantive engagement on the development at key milestones.

In addition to stakeholders involved in Valley Water's two countywide reuse workshops that preceded Project initiation, Valley Water invited representatives from a broad range of interest groups to participate, including non-utilities (chambers of commerce and organizations representing business interests, planning, public policy, environmental, environmental justice, diversity, and stormwater) and utilities (potable and recycled water retailers, wholesale water suppliers, and wastewater/recycled water agencies from the broader region). To enable meaningful engagement, the number of direct TF participants was limited to a manageable number, and Valley Water extended invitations to representatives of key stakeholder groups.

A charter guided the Stakeholder TF's decision making, process fundamentals, engagement expectations, and lines of communication. Draft work products were provided in advance to enable productive in-person dialogue during Stakeholder TF workshops. Participants were expected to provide feedback on approach, work completed to date, and planned next steps in written comments and during workshops, which have been documented and integrated into the Master Plan to the extent practicable.

3.5.4 Independent Advisory Panel

Valley Water is convening the IAP to review the recommended alternatives and the related regulatory compliance plan. Members of this existing group are nationally recognized reuse experts and will be tapped to guide Valley Water's PR efforts. Valley Water is coordinating with the National Water Research Institute (NWRI) to evaluate the technical, scientific, and regulatory aspects of the feasible Project alternatives, and to solicit IAP feedback for recommended Project alternatives. The IAP's input has been considered in refining project portfolios and elements and the regulatory compliance plan for each.

3.5.5 Regulators

To inform development of the feasible portfolios, Valley Water will hold several meetings with relevant regulators, including DDW and the SFB / Central Coast Regional Water Quality Control Board. This collaborative approach is intended to garner regulators' input, with the objective of gaining support on Project concepts and regulatory compliance plan.

3.5.6 Public

Consistent with Valley Water's past and ongoing reuse efforts, public engagement and support is critical to the Master Plan's success. Valley Water will hold a public meeting to present the draft Master Plan for input and respond to questions.

Section 4: Next Steps

This Project Definition, Roles, and Responsibilities TM provides a basis for the Countywide Water Reuse Master Plan. Additional interim work products will further build on this TM as elements that Valley Water will integrate into the Master Plan, including those described in Section 1.

Going forward, Valley Water will implement the engagement strategy described in Section 3 to collaborate on Master Plan development with the Partner Agencies and external stakeholders.

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Attachment A: Relevant Planning Studies (Reference List)

Table A-1. Valley Water-Provided References Used in Project Definition, Roles, and Responsibilities TM	
Reference Title or Description	**Date**
City of Palo Alto, Recycled Water Facility Plan	December 2008
South Bay Water Recycling, Strategic and Master Planning Vol. 1 & Vol. 2	December 2014
City of Sunnyvale, Feasibility Study for Recycled Water Expansion Report	June 2013
City of Sunnyvale, 2015 Urban Water Management Plan	June 2016
South County Recycled Water Master Plan Update Final	May 2016
Valley Water, 2015 Urban Water Management Plan	May 2016
Valley Water, 2012 Water Supply and Infrastructure Master Plan	October 2012
City of Palo Alto, 2015 Urban Water Management Plan	June 2016
City of Palo Alto, Valley Water, City of Mountain View, Final Advanced Water Purification System Feasibility Study	May 2017
San Francisco Bay Regional Water Quality Control Board, NPDES Permit No. CA0037834	2014
City of Mountain View, 2015 Urban Water Management Plan	June 2016
Report to the City Council, City of San José, South Bay Water Recycling: Better Information and Renegotiation of Contractual Obligations Will Increase Transparency and Aid Program Success	March 2016
San José Municipal Water System, 2015 Urban Water Management Plan	June 2016
San Francisco Bay Regional Water Quality Control Board, NPDES Permit No. CA0037842, R2-2014-0034	September 2014
San Jose Water Company, 2015 Urban Water Management Plan	June 2016
City of Gilroy, 2015 Urban Water Management Plan	May 2016
Central Coast Regional Water Quality Control Board, NPDES Permit No: CA0049964, R3-2010-0009	March 2010
City of Sunnyvale, 2016 Recycled Water Annual Report	2016
City of Sunnyvale, Plant Compliance, Annual NPDES Report	2016
San Francisco Regional Water Quality Control Board, NPDES Permit No: CA0037621, R2-2014-0035	November 2014
Valley Water, Groundwater Management Plan 2016	2016
Valley Water, Draft Expedited Purified Water Program Plan	March 2018
Valley Water, One Water Plan	September 2016
San José Green Vision Plan	2007
Valley Water, Water Supply Master Plan 2040	November 2019
City of Palo Alto, Valley Water, City of Mountain View Northwest County Recycled Water Strategic Plan	July 2019

Note: Agreements are listed in Table B-1 and referenced by agreement number.

Attachment B: Past and Current Agreements List

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Table B-1. Past and Current Agreements between Valley Water and External Partners

Agreement Number	Type	Subject	Partner	Partner Commitment	Valley Water Commitment	Transfer Opportunity	Date Signed	End Date
Palo Alto/Mountain View Agreements								
A3968S	Cost-sharing/funding	AWPF feasibility (consultant support)	Palo Alto	$65,175	$260,700		5/16/2016	12/31/2017[a]
A4040S	Cost-sharing/funding	Northwest County Recycled Water Strategic Plan (consultant support)	Palo Alto	$200,000	$1,800,000		12/15/2016	12/30/2020
A4103M	Water reuse alternatives	Water Reuse Alternatives (WRA) feasibility (investigating supply, sites)	Palo Alto			10 mgd effluent from Palo Alto RWS to Valley Water	8/28/2017	12/31/2020
A4040S	Water reuse alternatives	WRA feasibility (investigating sites)	Mountain View				10/11/2017	12/31/2020
	Cost-sharing and supply commitment	"Local" enhanced recycled water facility construction (~$20M) Supply commitment for Valley Water-owned Regional AWPF	Palo Alto / Mountain View	$1,000,000 (Palo Alto) $3,000,000 (Mountain View)	$16,000,000	9 mgd (minimum annual average flow) effluent from Palo Alto RWS to Valley Water at a cost of ~$100/AF	12/10/2019	12/10/2095
SBWR Agreements								
A2122	Cost-sharing/funding	Development and utilization of NPR (SBWR)	San José		$115/AFY		4/7/1998	6/30/2002[a]
A2517S	Cost-sharing/funding	Silver Creek pipeline (management and operation)	San José	$19,500,000	$6,500,000	5 mgd effluent from SBWR to Valley Water	1/22/2002	1/22/2027
A3339RE	Land use	Right of entry for SVAWPC land	San José				11/13/2009	6/30/2014[a]
A3350S	Supply commitment and land use	SVAWPC (supply transfer and property use)	San José	None (San José owns the property)	$10/year (Valley Water rents the property)	12 mgd secondary effluent from SBWR to Valley Water; 8 mgd from SVAWPC to SBWR	3/2/2010	6/30/2050
A3351S	Cost-sharing/funding	SVAWPC construction	San José	$11M	$36.25M		3/2/2010	6/30/2050
A3596S	Cost-sharing/funding	SBWR improvements/expansions (consultant support)	San José	$1,200,000	$1,200,000		6/28/2012	6/30/2014[a]
A3622S	Operations and maintenance	SVAWPC	San José			1.5 mgd waste stream discharge and 2 mgd RO concentrate from SVAWPC to SJ/SC RWF	12/15/2016	6/30/2050
SCRWA Agreements								
A2280-1	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA	50% of consultant cost	50% of consultant cost		10/5/1999	10/31/2019[a]
A2280-2	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA				10/5/1999	10/31/2019[a]
A2280-3	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA				10/5/1999	10/31/2019[a]
A2280W-4	Producer-wholesaler	Supply, Master Plan/CIP preparation (consultant support)	SCRWA	50% programmatic-level EIR	100% project-level EIR and cost of NPR reservoir		12/12/2006	12/31/2026
A3426S	Cost-sharing/funding	Pipeline construction	SCRWA	$2,151,800	$160,000		12/1/2010	Until complete
A3501X	Infrastructure ownership	Water meter transfer	Gilroy				7/1/2011	Until complete
A3828G	Cost-sharing/funding	Pipeline construction	Gilroy	Unknown	$6,787,888		2/26/2015	Until complete
A3829G	Cost-sharing/funding	Pipeline construction	Gilroy	Unknown	$26,762,678		2/26/2015	Until complete

Table B-1. Past and Current Agreements between Valley Water and External Partners

Agreement Number	Type	Subject	Partner	Partner Commitment	Valley Water Commitment	Transfer Opportunity	Date Signed	End Date
Sunnyvale Agreements								
A3683S	Cost-sharing/funding	Wolfe Road pipeline planning/design (consultant and staff support)	Sunnyvale	$625,000	$625,000		9/24/2013	6/30/2014[a]
A3807A	Cost-sharing/funding	Sunnyvale WPCP AWPF (consultant support)	Sunnyvale		$618,735		12/31/2014	12/31/2018[a]
A3825S	Supply commitment	Recycled water supply to Wolfe Road pipeline	Sunnyvale			1,095 AFY (0.98 mgd) total from Sunnyvale to Valley Water (595 AFY [0.53 mgd] reserved for use in Sunnyvale and 500 AFY [0.45 mgd] for other service areas)	2/6/2015	2/6/2025 (renews every 5 years)
A3822S	Cost-sharing/funding	Wolfe Road pipeline construction – local funding (partially funded by State drought grant, per Agreements A3984R and A3985R)	Sunnyvale	$1,475,000 (initial cost share)	$8,500,000 (initial cost share)		2/6/2015	6 months post-construction
A3984R	Cost-sharing/funding	Wolfe Road pipeline construction – grant reimbursement ($4M in State drought grant funding from ABAG/SFEP[b], passed-through to Valley Water and Sunnyvale as subrecipients with a $6M local cost share, per A3985R)	Sunnyvale	($1,500,000) (reimbursement)	($2,500,000) (reimbursement)		7/20/2015	5/1/2019[a]
A3985R	Cost-sharing/funding	Wolfe Road pipeline construction – local cost share	Sunnyvale	$800,000 (funding match)	$5,200,000 (funding match)		5/17/2016	Until complete
A3821S	Cost-sharing/funding	Wolfe Road pipeline construction	Cal Water	$1,500,000			2/10/2015	2/10/2025
A3823S	Cost-sharing/funding	Wolfe Road pipeline construction	Apple	$4,800,000		0.23 mgd from Sunnyvale to Apple	2/13/2015	3 years post-construction
Sunnyvale Agreements (continued)								
A3824S	Infrastructure ownership	Wolfe Road pipeline crossing construction (Valley Water to own crossing)	Apple	Construction cost			2/13/2015	3 years post-construction
A4076M	Water reuse alternatives	WRA feasibility (cost-sharing and supply)	Sunnyvale		$200,000		6/15/2017	12/31/2020
Other Agreements								
A4064S	Water reuse alternatives	Expedited program (consultant support)	SFPUC/BAWSCA	$37,500	$37,500		3/28/2017	12/31/2018[a]
A3787S	Cost-sharing/funding	Overall recycled water program support (one-time contribution)	Cinnabar Hills Golf Club	$647,520			10/14/2014	Not applicable

a. Expired.

b. SFEP: San Francisco Estuary Partnership.

Appendix E-1: Baseline Analysis

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75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC Internal)

Contract no.: A4120A

Appendix E-1

Subject: Baseline Analysis

Date: October 4, 2018 (reissued June 30, 2020)

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, BC Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

Prepared by: Curtis Lam, HydroScience Engineers
California License C59049

Melanie Holmer, P.E., Brown and Caldwell
California License C63236

Brian Pecson, Trussell Technologies
California License C80440

Reviewed by: Brett Farver, P.E., Brown and Caldwell
California License C58466

Limitations:

This document was prepared solely for Valley Water in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

Table of Contents

Executive Summary 1

Section 1: Existing Reuse Systems in Santa Clara County 6

1.1 Service Areas 6
  1.1.1 Palo Alto/Mountain View 9
  1.1.2 Sunnyvale 9
  1.1.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling 9
  1.1.4 Silicon Valley Advanced Water Purification Center 9
  1.1.5 South County Regional Wastewater Authority 10
1.2 Governance 10
  1.2.1 Palo Alto/Mountain View 10
  1.2.2 Sunnyvale 10
  1.2.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling 11
  1.2.4 South County Regional Wastewater Authority 12
1.3 Finances 13
  1.3.1 Water Rates 13
  1.3.2 Financial Obligations/Operating Requirements 14
1.4 Recycled Water Demands 15
1.5 System Performance and Challenges 16
  1.5.1 Treatment Facilities 16
  1.5.2 Distribution System Infrastructure 18
  1.5.3 System Deficiencies 19

Section 2: Potable Reuse Research and Planning 20

2.1 Full-Scale Performance Testing 20
  2.1.1 Microfiltration 21
  2.1.2 Reverse Osmosis 21
  2.1.3 UV Treatment 21
  2.1.4 Monitoring 21
  2.1.5 Water Quality 21
2.2 Pilot UV/AOP Testing 21
2.3 Pilot Ozone/BAF Testing 22
  2.3.1 Ozone/BAF for Groundwater Spreading 22
  2.3.2 Ozone/BAF as Pretreatment for DPR 23
2.4 Groundwater Conditions 23
  2.4.1 Groundwater Modeling 23
  2.4.2 Groundwater Monitoring 24
  2.4.3 Dissolution Studies 24

Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

2.5 Independent Advisory Panel Engagement 24
Section 3: Expanded Reuse Opportunities and Considerations 24
3.1 Preliminary Assessment of Volume Available and NPR/PR Split 24
    3.1.1 Volume Available 24
    3.1.2 NPR/PR Split 34
    3.1.3 ROC Management Considerations 41
3.2 Countywide Opportunities 42
    3.2.1 Improvements via Interties 42
    3.2.2 Projected CIP Projects 42
3.3 Considerations 46
    3.3.1 Public Engagement and Perception 46
    3.3.2 Source Water Reliability 48
Section 4: Gap Analysis 48
4.1 Data Supporting Potable Reuse Regulatory Approval 49
    4.1.1 Groundwater Recharge 50
    4.1.2 Direct Potable Reuse 53
4.2 Project Requirements 55
4.3 Resource Gaps 55
References 56

Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

List of Figures

Figure 1-1. County recycled water distribution systems 7

Figure 2-1. Treatment trains investigated with ozone/BAF piloting 22

Figure 3-1. Example flow streams were identified to establish the baseline condition 25

Figure 3-2. Process for analyzing existing data and establishing the baseline condition 26

Figure 3-3. 2015 recycled water demand, as presented in 2015 UWMPs 27

Figure 3-4. ADWF projections from the PA/MV RWQCP Long Range Facilities Plan, adjusted for current flows 30

Figure 3-5. Process used to estimate remaining effluent available for discharge, blending, or as AWPF feed 31

Figure 3-6. Sunnyvale WPCP: average plant influent, categorized by NPR demands, evaporative losses (based on current evaporation rates), and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 35

Figure 3-7. Sunnyvale WPCP: average plant influent, categorized by NPR demands, 4 mgd of evaporative and other losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 36

Figure 3-8. SJ/SC RWF: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 37

Figure 3-9. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 1 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 38

Figure 3-10. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 3 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 39

Figure 3-11. SCRWA WWTP: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035 40

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List of Tables

Table ES-1. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035 4

Table ES-2. PR Gap Analysis Recommendations 5

Table 1-1. Water Consumption Rates for Potable and Recycled Water 13

Table 1-2. Current and Projected Recycled Water Demands from 2015 UWMPs 16

Table 1-3. Treatment Facility Flows and Recycled Water Production 17

Table 1-4. Recycled Water System Deficiencies 20

Table 3-1. Current Flows: Plant Influent (mgd) and Monthly Distribution Factors 28

Table 3-2. Current Demands: NPR Demand (mgd) and Monthly Distribution Factors for Each Plant 29

Table 3-3. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035 33

Table 3-4. Short-listed ROC Management Options to be Further Considered (as of 2017) 41

Table 3-5. Potential Interties to Increase Supply Reliability 42

Table 4-1. PR Gap Analysis Recommendations 49

Table 4-2. Potential Terms for Purified Water MOU with CSJ 53

Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

List of Abbreviations

ADWF	average dry weather flow
AFY	acre-feet per year
AOP	advanced oxidation process
AWPF	advanced water purification facility
BAF	biologically active filtration
Cal Water	California Water Service Company
CEC	contaminants of emerging concern
CEQA	California Environmental Quality Act
CIP	capital improvement program
CISP	Capital Improvements Strategic Plan
CIWQS	California Integrated Water Quality System
County	Santa Clara County
CT	product of disinfectant residual concentration and contact time
DBP	disinfection by-product
DDW	Division of Drinking Water
DPR	direct potable reuse
EIR	Environmental Impact Report
ESD	Environmental Services Department
FAT	full advanced treatment
gpm	gallon(s) per minute
GWR	groundwater recharge
H_2O_2	hydrogen peroxide
IAP	Independent Advisory Panel
IPR	indirect potable reuse
JRWC	Joint Recycled Water Committee
LF	linear foot/feet
LRV	log removal value
Master Plan	Countywide Water Reuse Master Plan
mg/L	milligram(s) per liter
MF	microfiltration
MG	million gallons
mgd	million gallons per day
MOU	memorandum of understanding
N/A	not applicable
NDMA	N-nitrosodimethylamine
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
O&M	operations and maintenance
P3	public-private partnership
PA/MV	Palo Alto/Mountain View
PR	potable reuse
Program Plan	Draft Expedited Purified Water Program Plan
PWWF	peak wet weather flow
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWF	regional wastewater facility
RWQCB	Regional Water Quality Control Board
RWQCP	Regional Water Quality Control Plant
SAT	soil aquifer treatment
SBWR	South Bay Water Recycling
SCRWA	South County Regional Wastewater Authority
SF Bay	San Francisco Bay
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SJW	San Jose Water[1]
SLPS	San Lucar Recycled Water Pump Station
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TM	Technical Memorandum
TOC	total organic carbon
TPAC	Treatment Plant Advisory Committee
TPS	transmission pump station
UF	ultrafiltration
UV	ultraviolet
UWMP	urban water management plan
Valley Water	Santa Clara Valley Water District
WPCP	water pollution control plant
WSMP	Water Supply Master Plan
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in its name, though City of San José does.

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Executive Summary

The Santa Clara Valley Water District's (Valley Water) Countywide Water Reuse Master Plan (Master Plan) aims to improve water supply reliability through water reuse for Santa Clara County (County) in collaboration with recycled water producers, wholesalers, retailers, users, and other interested parties. The Master Plan will identify the volume of water available for potential potable reuse (PR) development and non-potable reuse (NPR) expansion, the optimal allocation between PR and NPR, options for system integration, recommendations for building on NPR projects and creating new PR projects, and proposals for governance model alternatives, including roles and responsibilities. The Master Plan aligns with Valley Water's Water Supply Master Plan (WSMP; updated in 2019) that describes their strategy for providing a reliable and sustainable water supply in a cost-effective manner.

Before exploring conceptual and feasible water reuse alternatives, Valley Water gathered up-to-date information for recycled water facilities in the County. This Baseline Analysis presents a review of existing information and analyses to establish existing conditions for the recycled water facilities and distribution systems in the County. This evaluation also includes a preliminary assessment of the volume of water available for reuse, the potential NPR/PR split, and a summary of potential infrastructure improvements. The Baseline Analysis is intended to inform development of conceptual alternatives and, ultimately, the final Master Plan.

Existing Systems

Four recycled water systems in the County produce water for NPR: (1) Palo Alto/Mountain View (PA/MV), (2) Sunnyvale, (3) South Bay Water Recycling (SBWR), and (4) South County Regional Wastewater Authority (SCRWA). The Silicon Valley Advanced Water Purification Center (SVAWPC) further treats some of the recycled water for SBWR.

Palo Alto/Mountain View

The Palo Alto Regional Water Quality Control Plant (RWQCP) produces recycled water for customers in Palo Alto and the North Bayshore area of Mountain View. The RWQCP can currently produce up to 4.5 million gallons per day (mgd) of recycled water, though much of its equipment requires rehabilitation or replacement. PA/MV also plans to extend its recycled water distribution system. The most notable challenges for the PA/MV recycled water system are high salinity in the source water and insufficient storage.

Valley Water and the City of Palo Alto entered into a memorandum of understanding (MOU) in 2017 to assess the feasibility of developing water reuse alternatives. This MOU was replaced by a full Agreement between Palo Alto, Mountain View, and Valley Water, effective December 10, 2019. Valley Water and Palo Alto continue to coordinate efforts through a Joint Recycled Water Committee.

Sunnyvale

The Donald M. Somers Water Pollution Control Plant (WPCP) supplies the Sunnyvale recycled water system. The City of Sunnyvale is currently upgrading the WPCP, which will increase recycled water production capacity to 4 mgd. Overall, the Sunnyvale recycled water system is very reliable, with potable water backups at the WPCP pump station and the San Lucar tank, and the ability to feed the entire system from the San Lucar Recycled Water Pump Station.

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The City of Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for service to the Wolfe Road pipeline. Along the Wolfe Road pipeline, Valley Water is the wholesaler, and California Water Service Company is the retailer. In 2017, Valley Water and City of Sunnyvale entered into an MOU to collectively study the feasibility of various recycled water system upgrades, including construction of an advanced water purification facility (AWPF) and potential interties between Sunnyvale, PA/MV, and SBWR systems.

SBWR

SBWR delivers recycled water produced at the San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF) to customers in the cities of San José, Santa Clara, and Milpitas. Recycled water production is limited to 38 mgd by the granular media filters. Up to 8 mgd of this supply can originate from SVAWPC.

A 2010 Condition Assessment concluded that the system is generally well-maintained and in good condition, but some facilities, including communications, valves, and transmission pumps and electrical components, are nearing the end of their useful lives. SJ/SC RWF is implementing a $2 billion capital improvement program over the next 30 years to address these needs.

In 2010, Valley Water and the City of San José agreed to formally coordinate recycled water efforts by creating a Joint Recycled Water Policy Advisory Committee. This Committee advises the Valley Water Board and the City Council of the City of San José on policy matters relating to the production, distribution, and use of recycled water.

SVAWPC

Valley Water's SVAWPC opened in 2014 to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology. SVAWPC can produce up to 8 mgd and employs many of the treatment processes needed for PR. SVAWPC applies microfiltration (MF), reverse osmosis (RO), and ultraviolet (UV) light disinfection to a side stream of regional wastewater facility water to improve the quality of SBWR water.

SCRWA

The SCRWA Wastewater Treatment Plant (WWTP) was built in 1990 to serve the cities of Gilroy and Morgan Hill and can currently produce up to 8 mgd of recycled water. SCRWA and Valley Water executed a producer-wholesaler agreement and a wholesaler-retailer agreement in 1999 for a 20-year term. Following this term, the agreements are automatically renewed and extended annually for 1 year unless terminated by the parties.

The City of Gilroy, on behalf of Valley Water, operates and maintains the distribution pump station and tank. Valley Water maintains distribution pipelines and wholesales recycled water. Redundancy from system storage protects against treatment disruptions, and though pumping is vulnerable there are plans to add a new pump. Planned long-term capital improvements also include adding capacity to the WWTP.

Potable Reuse Research and Planning

Valley Water has undertaken several research efforts to evaluate indirect potable reuse (IPR) through groundwater recharge (GWR) and direct potable reuse (DPR), with the following goals:

- Demonstrate compliance with the regulatory requirements for GWR at both pilot and full scale
- Evaluate alternatives to upgrade the UV disinfection system to an advanced oxidation process (AOP)
- Evaluate ozone with biologically active filtration to spread GWR and in DPR
- Educate stakeholders on SVAWPC's ability to create high-quality water for PR

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Valley Water's Expedited Purified Water Program evaluated several options for PR. Through this effort, Valley Water identified a groundwater spreading project as its recommended first phase, which includes delivering 24 mgd of full advanced treatment (i.e., MF, RO, and an AOP) water from an expanded SVAWPC to the Los Gatos Ponds.

Expanded Reuse Opportunities and Considerations

Valley Water requested data from the Palo Alto RWQCP, Sunnyvale WPCP, SJ/SC RWF, and SCRWA WWTP to establish current conditions and projected future conditions to determine the volume available for NPR and PR. Using plant influent and outflow streams, a flow balance was created to calculate the remaining effluent available (i.e., plant influent minus losses, environmental flows, and NPR demands).

In this analysis, the remaining effluent available for discharge, blending, or additional reuse (above and beyond the 2015 Urban Water Management Plan [UWMP] recycled water demand projections) was estimated. Annual averages are summarized in Table ES-1 for the years 2025 and 2035. These flows may not be available year-round, particularly in the summer months. Furthermore, some agencies have contractual agreements restricting the use of certain flows, and making these flows available for Valley Water would require new agreements. For this analysis, it was assumed that NPR demands will increase per the future values estimated in the 2015 UWMPs, and any remaining effluent (as shown in Table ES-1) will be available for discharge, blending, or as source water for PR (i.e., feed water for an AWPF). Some of this flow may be rejected in the reverse osmosis concentrate (ROC) stream, or used to dilute the ROC for discharge, depending on the findings of Valley Water's ROC management study. Flow estimates are preliminary and may be refined as more recent data and/or projections become available.

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Table ES-1. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035

Partner Agency	Available Influent, mgd (AFY)[a]	NPR Demands, mgd (AFY)	Losses/Environmental Flows, mgd (AFY)	Remaining Effluent, mgd (AFY)[b]	Current Contractual Obligation[c]
2025					
Palo Alto RWQCP	21.0 (23,400)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	15.2-17.2 (16,900–19,200)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	14.6 (16,300)	1.4 (1,600)	1.4-4.0[e] (1,600–4,500)	9.2-11.8 (10,300-13,200)	See footnote (f)
SJ/SC RWF	103.2 (115,600)	18.1 (20,300)	0	85.1 (95,300)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	2.8 (3,100)	0	3.7 (4,200)	N/A
Total, 2025 [g]	**145.3 (162,700)**	**24.8 (27,900)**	**2.7-7.3 (3,000-8,200)**	**113.2—117.8 (126,700-131,800)**	
2035					
Palo Alto RWQCP	22.1 (24,700)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	16.3-18.3 (18,200–20,400)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	17.3 (19,400)	1.5 (1,700)	1.4-4.0[e] 1,600–4,500	11.8-14.4 (13,200-16,100)	See footnote (f)
SJ/SC RWF	107.4 (120,200)	21.5 (24,200)	0	85.9 (96,000)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	3.3 (3,700)	0	3.2 (3,600)	N/A
Total, 2035 [g]	**153.3 (171,600)**	**28.8 (32,400)**	**2.7-7.3 (3,000-8,200)**	**117.2-121.8 (131,000-136,200)**	

a. *Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies.*

b. *Calculated as available influent less the sum of 2015 UWMP NPR demand estimates, environmental flows, and other losses (such as in-plant process water losses).*

c. *Projected NPR demands do not fully capture potential allocations per contractual agreements. New agreements may be needed to access portions of available effluent for additional reuse. Governance considerations will be further evaluated as the Master Plan progresses.*

d. *Range reflects flow to Renzel Marsh currently included in the NPDES permit (1 mgd) and a high estimate (3 mgd), in case of a future expansion, along with an estimated 0.3-mgd loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).*

e. *Range reflects current evaporation rates and higher estimate reserved for evaporation, capping, and other losses.*

f. *Per agreement between Sunnyvale and Valley Water, Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits. Valley Water and Sunnyvale meet annually to discuss the anticipated quantity of recycled water to be delivered through the Wolfe Road Pipeline to Valley Water customers.*

g. *Difference due to rounding.*

AFY = acre-feet per year; N/A = not applicable

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To expand capacity and reliability of the County's existing recycled water systems, several projects are under consideration, including interties for existing NPR, connections between potential PR systems, and major CIP projects. Factors that must be considered when expanding water reuse include public perception and supply reliability.

Gap Analysis

Valley Water has undertaken multiple efforts to demonstrate the effectiveness of GWR for IPR and is also exploring DPR as a water supply option; however, there are several gaps that require further clarification or study. Table ES-2 summarizes recommendations for future GWR and DPR efforts.

Table ES-2. PR Gap Analysis Recommendations

Consideration	Recommendation	
	GWR	DPR
Treatment	• Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Additional testing if Valley Water decides to pursue non-RO-based groundwater spreading options	• Additional testing of ozone/BAF to improve dosing control and assess benefits for downstream processes and ROC management • Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Demonstration testing of DPR treatment train to gain experience with integration of high-frequency data collection
Source water quality	• Characterize potential source waters for key constituents (e.g. N-nitrosodimethylamine [NDMA])	• Consider quality of feedwater needed for DPR (e.g. nitrified/denitrified, tertiary filtered) • Consider pathogen monitoring study at WWTP to obtain removal credits
Regulations	• No regulatory gaps: GWR regulations finalized in 2014	• DPR regulations not anticipated until 2023 • Consider potential additional requirements, e.g. treatment, monitoring, operations
Source control	• Begin coordination with wastewater provider to broaden source control program	
Groundwater characterization	• Characterize groundwater basin retention times through tracer studies • Characterize availability of diluent water for tertiary spreading • Continue characterizing water quality of existing basins	N/A
Environmental discharge	• Evaluate compliance with Salt and Nutrient Management Plans and antidegradation regulations • Likely to be more challenging with GWR via tertiary spreading	N/A
Source water availability	• Secure institutional agreements with recycled water producers	
ROC management	• Continue evaluating ROC management strategies • Coordinate with wastewater agencies, regulatory agencies, and interested stakeholders to implement ROC management	
Demand (water supply needs)	• Valley Water plans to complete the WSMP in coordination with this Master Plan	
Utilization rate	• Valley Water plans to complete the WSMP in coordination with this Master Plan	

Section 1: Existing Reuse Systems in Santa Clara County

Santa Clara County (County) has four recycled water systems that deliver water for non-potable reuse (NPR): (1) Palo Alto/Mountain View (PA/MV), (2) Sunnyvale, (3) South Bay Water Recycling (SBWR), and (4) South County Regional Wastewater Authority (SCRWA), referred to collectively as the Countywide Water Reuse Master Plan Partner Agencies. The Santa Clara Valley Water District's (Valley Water) Silicon Valley Advanced Water Purification Center (SVAWPC) opened in 2014 to reduce the salinity of SBWR recycled water and demonstrate advanced treatment technology.

This section provides an overview of each system's service area, governance structure, and financial status, and summarizes current and projected recycled water demands, treatment plant capacity, and system deficiencies.

1.1 Service Areas

This section describes each recycled water system's current service area, along with long-term expansion plans. Figure 1-1 shows the locations of treatment plants and pipelines for each system.

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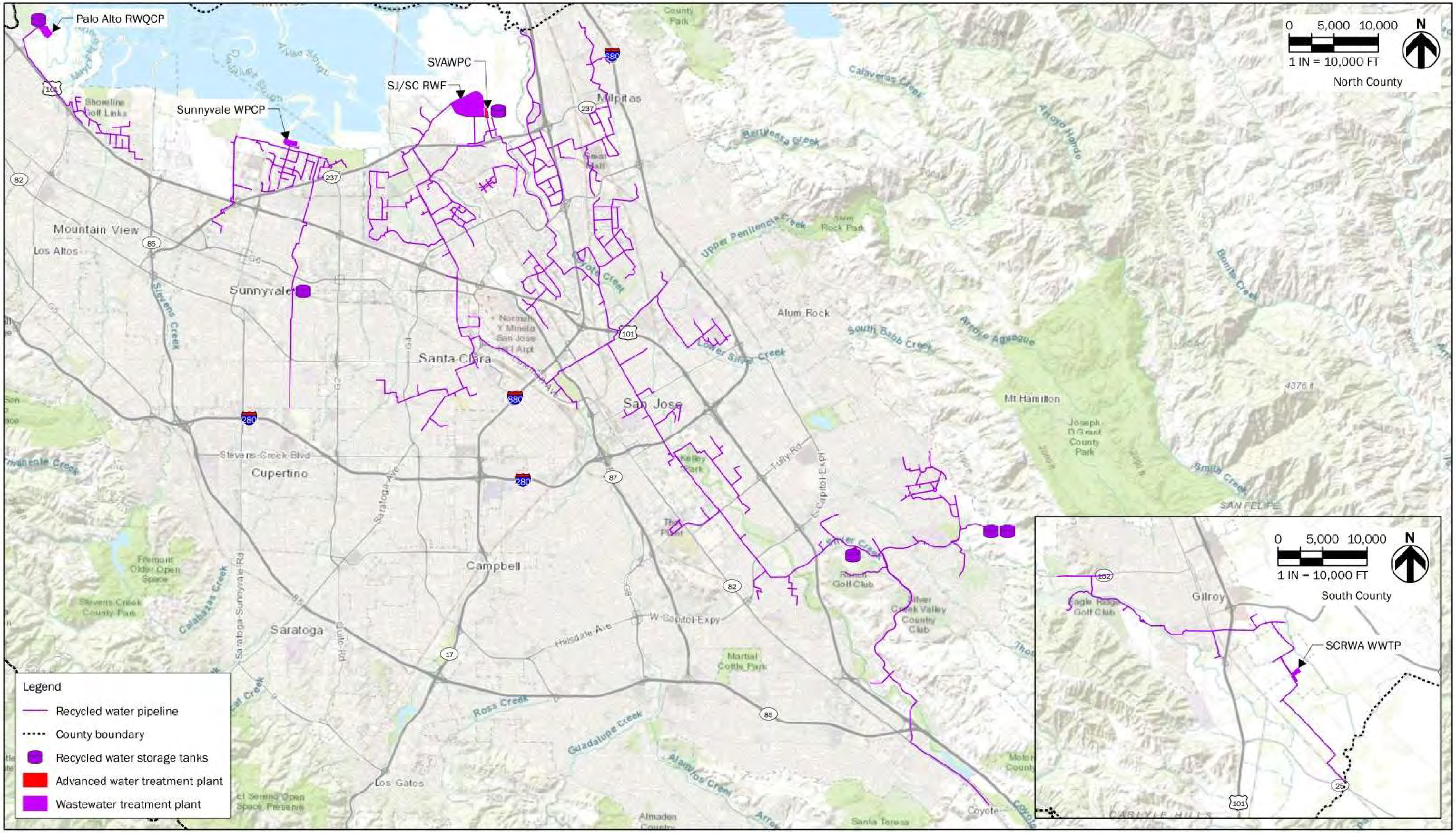

Figure 1-1. County recycled water distribution systems

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1.1.1 Palo Alto/Mountain View

The Palo Alto Regional Water Quality Control Plant (RWQCP) treats wastewater for the cities of Palo Alto, Mountain View, Los Altos, and Los Altos Hills; East Palo Alto Sanitary District; and Stanford University. Owned and operated by the City of Palo Alto, the RWQCP produces recycled water for Palo Alto customers near the plant and the North Bayshore area of Mountain View.

PA/MV has planned recycled water distribution system extensions. The Palo Alto Recycled Water project plans to construct 11 miles of pipeline to serve approximately 50 locations within South Palo Alto, including Alta Mesa Memorial Park. The City of Palo Alto envisions that future extensions of this pipeline may provide connectivity to future Mountain View, Los Altos, and Los Altos Hills NPR project extensions. The City of Mountain View's 2014 Recycled Water Feasibility Study identified several options for a multi-phase expansion called the Whisman School Park/Central Expressway Alignment. This extension includes approximately 36,000 linear feet (LF) of new pipeline throughout the City of Mountain View.

Additionally, Palo Alto is planning construction of a 1.25 to 2.5 million gallons per day (mgd) advanced water purification facility (AWPF) near the Palo Alto RWQCP to blend purified water with recycled water to reduce salinity.

1.1.2 Sunnyvale

The Donald M. Somers Water Pollution Control Plant (WPCP) supplies the Sunnyvale recycled water system. The WPCP is owned and operated by the City of Sunnyvale. The recycled water distribution network mainly serves customers north of Highway 237, though a recently installed main on Wolfe Road extends south to serve the new Apple Campus in Cupertino.

In June 2013, the City of Sunnyvale finalized a Feasibility Study for Recycled Water Expansion Report that identified new recycled water alignments and pumping/storage upgrades to meet near-term demands (City of Sunnyvale 2013b). Including the completed Wolfe Road recycled water pipeline, new alignments total 97,600 LF of new pipe and include extensions from existing and proposed pipes and a new main loop connecting to the Wolfe Road main.

Valley Water oversized the Wolfe Road recycled water pipeline for NPR within Sunnyvale and Cupertino. The additional capacity considers potential future conversion of this pipeline into a purified water pipeline for groundwater recharge (GWR).

1.1.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling

The San José-Santa Clara Regional Wastewater Facility (SJ/SC RWF) treats wastewater from the cities of San José, Santa Clara, Milpitas, Campbell, Cupertino, Los Gatos, Monte Sereno, and Saratoga. It is co-owned by the City of San José and the City of Santa Clara but operated solely by the City of San José as the administrative agency. SBWR delivers recycled water produced at the SJ/SC RWF to customers in the cities of San José, Santa Clara, and Milpitas.

Future non-potable recycled water expansion is focused in Milpitas and central and southern San José. For additional information, refer to Section 3.2.2.

1.1.4 Silicon Valley Advanced Water Purification Center

Valley Water owns and operates the SVAWPC located on Zanker Road, just across the street from the SJ/SC RWF in San José. SVAWPC was developed to further enhance the quality of SBWR recycled water. Because the facility employs many of the treatment processes needed for PR, it has also been used to evaluate PR as a future water supply option.

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1.1.5 South County Regional Wastewater Authority

The South County Regional Wastewater Treatment and Reclamation Facility supplies recycled water customers in Gilroy. While the wastewater treatment plant (WWTP) treats wastewater from the cities of Gilroy and Morgan Hill, the recycled water pipeline extends only to Gilroy. One branch runs north and west to Eagle Ridge Golf Course; the southern branch delivers recycled water to two farms along Sheldon Avenue.

Valley Water is installing an additional 14,500-LF NPR pipeline in western Gilroy, coordinated in part with new developments planned in Gilroy.

1.2 Governance

This section reviews the governance framework for each recycled water system, including managing treatment/production and producer/wholesaler/retailer relationships.

1.2.1 Palo Alto/Mountain View

The City of Palo Alto Department of Public Works Environmental Services Division operates and maintains the RWQCP. The City of Palo Alto is the producer and wholesaler of recycled water for the PA/MV system, which treats wastewater from the communities of Los Altos, Los Altos Hills, Mountain View, and Palo Alto; Stanford University; and the East Palo Alto Sanitary District. Palo Alto and Mountain View each retail recycled water to customers within their city limits.

Valley Water and the City of Palo Alto entered into a Memorandum of Understanding (MOU) in 2017 to coordinate their efforts to study multiple items, including:

- Evaluating water reuse alternatives, including opportunities to transfer up to 10 mgd of RWQCP effluent, for expansion of recycled and purified water
- Evaluating the feasibility of constructing and operating an AWPF
- Evaluating water recharge and reuse alternatives identified in the Northwest County Recycled Water Strategic Plan
- Exploring future development of the PA/MV NPR system, including Valley Water’s potential governance role
- Developing a residuals management plan, permitting plan, and water quality monitoring plan
- Evaluating land options for locating an AWPF in Palo Alto

On December 10, 2019, Palo Alto, Mountain View, and Valley Water executed a full agreement, replacing the 2017 MOU. Valley Water and the City of Palo Alto are continuing to coordinate through the City of Palo Alto and Valley Water Elected Officials Joint Recycled Water Committee (JRWC) to provide updates on recycled water opportunities, advance common interests, and establish a collaborative process to facilitate policy discussion and share technical information on recycled water issues. JRWC comprises three Valley Water board members, two City of Palo Alto council members, one City of Mountain View council member, and one East Palo Alto council member. Formal actions recommended by JRWC must still go back to each member agency for formal approval. A Technical Advisory Committee was also created that consists of Valley Water and City of Palo Alto staff to review work products and make recommendations to JRWC.

1.2.2 Sunnyvale

The City of Sunnyvale Environmental Services Department (ESD) manages the Sunnyvale recycled water program, which consists of production/operation, distribution, permitting, and monitoring. Within ESD, the WPCP Division oversees production and pump station operation, while the Water and Sewer Division manages distribution and user permitting. Recycled water quality monitoring is handled by the Regulatory

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Programs Division. The City of Sunnyvale is the producer, wholesaler, and retailer for recycled water, except for service to the Wolfe Road pipeline. Along the Wolfe Road pipeline, Valley Water is the wholesaler, and California Water Service Company (Cal Water) is the retailer.

Since 2014, Valley Water and the City of Sunnyvale have entered into multiple agreements to collectively evaluate WWTP layouts and configurations that may provide Valley Water with treated wastewater for future PR. In 2017, Valley Water and the City of Sunnyvale entered into an MOU (that extends through December 31, 2020) to collectively study the feasibility of:

- Evaluating alternative WWTP layouts for the Sunnyvale WPCP upgrade
- Making treated effluent available to Valley Water at a site near the Sunnyvale WPCP (e.g., Recycle Hill)
- Evaluating the construction of an AWPF at the Sunnyvale WPCP
- Constructing a pipeline to convey treated wastewater from the Sunnyvale WPCP to an expanded SVAWPC in San José
- Constructing interties between the Sunnyvale and SBWR recycled water distribution systems
- Constructing an AWPF to manage Sunnyvale recycled water salinity
- Constructing an intertie to convey treated wastewater from the Palo Alto RWQCP for advanced treatment at either the Sunnyvale RWQCP or the expanded SVAWPC
- Assessing the feasibility of providing Valley Water with 5 mgd of effluent by the year 2020, and an additional 5 mgd of effluent after 2020 (10 mgd total)
- Developing a residuals management plan, permitting plan, and water quality monitoring plan

Cost-sharing activities were also allocated to Valley Water and City of Sunnyvale for this work based on the type of feasibility study or work to be performed. They are coordinating efforts through the City of Sunnyvale and Valley Water Elected Officials JRWC to provide updates on recycled water opportunities, advance common interests, and establish a collaborative process to facilitate policy discussion and share technical information on recycled water issues. Formal actions recommended by the JRWC must still go to back to each member agency for formal approval. This joint committee comprises three Valley Water board members and two City of Sunnyvale council members. A Technical Advisory Committee, consisting of Valley Water and City of Sunnyvale staff, has also been created to review work products and make recommendations to Valley Water and City of Sunnyvale.

This Master Plan is expected to help inform the governance, terms, and contents of future agreements between Valley Water and City of Sunnyvale.

1.2.3 San José-Santa Clara Regional Wastewater Facility/South Bay Water Recycling

Under the City of San José's ESD, SBWR's policies and budget are determined by the Treatment Plant Advisory Committee (TPAC) and San José's City Council. The TPAC is an advisory group to the City Councils of San José and Santa Clara and was created in 1959 by the Sewage Treatment Plant Agreement between San José and Santa Clara. The City of San José, in partnership with the City of Santa Clara, jointly owns, operates, maintains, repairs, and coordinates improvements to the SJ/SC RWF under this master agreement. Additionally, they jointly develop and administer amendments to contract and agreements, including interests in SJ/SC RWF to anyone other than the City of San José and the City of Santa Clara. While seven cities and sanitary/sanitation districts discharge wastewater to SJ/SC RWF under a series of additional master agreements, the City of San José is the administering agency, and its City Council is the final decision-making body.

Spanning multiple cities, the SBWR system involves more stakeholders and thus a more complex governance structure. Tertiary treated recycled water produced at the regional wastewater facility (RWF) is blended with advanced treated water produced at Valley Water's SVAWPC. SBWR delivers this blended

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recycled water to the SBWR distribution system and wholesales it to four retailers: (1) the City of Milpitas, (2) City of Santa Clara, (3) San José Municipal Water System, and (4) San Jose Water (SJW). Two other retailers, Cal Water and Great Oaks Water Company, are located within the SBWR service area but do not distribute SBWR recycled water.

The Ground Lease and Property Use Agreement between the City of San José and Valley Water allowed Valley Water to lease from the City of San José the premises and ancillary property where the SVAWPC is located. The lease extends through June 30, 2050, and requires Valley Water to make an annual payment to the City of San José to use the premises and ancillary property.

The Recycled Water Facilities and Program Integration Agreement created a mechanism for Valley Water and the City of San José to formally coordinate on financially supporting the production and use of recycled water. Terms of this agreement, which also extends through June 30, 2050, include:

- Creating the Joint Recycled Water Policy Advisory Committee (City of San José/Valley Water/City of Santa Clara TPAC) made up of three Valley Water Board members, one City of San José City Council member, and one City of Santa Clara Council member. The remaining member can be from any city or agency with voting membership in the TPAC. Similar to the JWRC, this committee tenders its advice to the Valley Water Board and each member agency's City Councils for formal approval of official actions.
- Creating a Technical Working Group that includes staff from Valley Water and the City of San José
- Approving budgets for SBWR and SVAWPC
- Operational Support Payments associated with profits/loss for the operating budgets of SBWR and the SVAWPC
- Constructing the SVAWPC
- Limiting the export of effluent outside the County by either Valley Water or City of San José through July 1, 2020. After 2020, export is allowed only if the demand for in-county use of recycled water is less than the available supply.

Valley Water and the City of San José executed the Operation and Maintenance Agreement for SVAWPC in October 2012. The agreement provides Valley Water with the rights to:

- Accept up to 12 mgd of secondary effluent from the SJ/SC RWF
- Operate, maintain, and monitor SVAWPC to produce purified water in accordance with permits obtained from Division of Drinking Water (DDW)
- Blend purified water with recycled water produced by the RWF
- Discharge up to 2 mgd of reverse osmosis concentrate (ROC) from SVAWPC to the RWF chlorine contact tanks

1.2.4 South County Regional Wastewater Authority

SCRWA is a joint powers authority created by the cities of Gilroy and Morgan Hill to manage wastewater treatment. An agreement among SCRWA, Valley Water, and the cities of Gilroy and Morgan Hill establishes SCRWA as the NPR producer, Valley Water as the wholesaler, and the cities of Gilroy and Morgan Hill as the retailers. The City of Gilroy currently retails recycled water. Recycled water facilities are not yet within Morgan Hill. Valley Water can sell recycled water directly to end users outside the City of Gilroy's service area.

The producer-wholesaler agreement between SCRWA and Valley Water was originally executed in 1999 for a 20-year term (i.e., to 2019). In 2006, SCRWA and Valley Water signed an amended agreement for another 20-year term. Following this term (i.e., after 2026), the agreement is automatically renewed and extended annually for 1 year unless terminated by the parties. Terms of the 2006 agreement included:

- Commitment by Valley Water to make "best efforts" to develop and encourage the use of recycled water.

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- Valley Water has the rights to use and first right of refusal for recycled water produced at the SCRWA WWTP, which is to be delivered at the point of connection with pressures between 80 and 110 pounds per square inch.
- Updating, at 5-year intervals, the recycled water master plan to design and construct recycled water distribution facilities. The plan must also include a phased capital improvement program (CIP) that includes WWTP improvements and distribution system extensions.
- SCRWA is responsible for facilities upstream of the point of connection at which water is delivered to Valley Water. Valley Water is responsible for facilities downstream of the connection point. Each party owns, operates, and maintains its facilities.

Valley Water and the City of Gilroy also executed a wholesaler-retailer agreement for NPR supply within the City of Gilroy. Originally executed in 1999 for a 20-year term, the agreement is also automatically renewed and extended annually for 1 year unless terminated by the parties.

1.3 Finances

This section examines the financial picture for each recycled water system, including retailer recycled water rates, major financial obligations, and operating requirements.

1.3.1 Water Rates

To encourage recycled water use, retailers typically set NPR rates lower than potable water rates. Table 1-1 compares the potable water and recycled water consumption rates for each retailer in the County that sells both.

Table 1-1. Water Consumption Rates for Potable and Recycled Water

Retailer	Unit Cost/100 Cubic Feet[a, b]		Source
	Potable Water	Non-Potable Recycled Water	
City of Palo Alto[c]	$9.33	Not applicable	City of Palo Alto Utility Rate Schedule W-7 (effective 7/1/18)
City of Mountain View[d]	$6.80	$3.75	City of Mountain View Water Rates website (effective 7/1/18)
City of Sunnyvale	$4.85	$4.37	City of Sunnyvale Fiscal Year 2018/19 Utility Fee Schedule
Cal Water	$5.7379	$5.7379	Schedule LS-1-NR and LS-6, Los Altos Tariff Area (effective 7/1/18)
City of Milpitas[e]	$5.13	$2.78	City of Milpitas Public Works Department website, "Service Rates and Fees"
City of Santa Clara[f]	$5.98	$3.26–$3.58	City of Santa Clara Water & Sewer Utilities website, "Water, Sewer and Recycled Water Rates" (effective 7/1/18)
San José Municipal Water System[g]	$2.04–$4.98	$2.711–$3.370	City of San José Water Utilities website, "Drinking Water Rates and Recycled Water Rates" (effective 7/1/18)
SJW	$4.72750	$4.2669	SJW Billing Schedules (effective 8/25/18)
City of Gilroy[h]	$2.82–$3.66	$0.69	City of Gilroy Water Fee Schedule rev. 7/1/18 and 2015 South County Recycled Water Master Plan Update, Appendix K (2014–15 rate)

a. *All charges are presented as generally for commercial users of water for irrigation and non-potable use.*
b. *Rates change regularly and include/exclude various other factors such as meter charges, taxes, and other fees.*
c. *Current recycled water users in the City of Palo Alto are City facilities and thus not charged for recycled water. Per the City of Palo Alto's municipal code (16.12.060), a 50 percent surcharge would be added to potable water rates if a customer irrigates with potable water when recycled water is available.*
d. *The City of Mountain View has uniform rates for all businesses.*
e. *In addition to usage, the City of Milpitas charges each customer $1.30 as a bi-monthly capital surcharge.*
f. *The City of Santa Clara charges a lower rate for industrial use than irrigation use.*
g. *San José Municipal Water potable water rates are based on location and zone. Recycled water rates are based on type of use.*
h. *The City of Gilroy charges a lower rate for agricultural use than municipal and industrial use.*

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1.3.2 Financial Obligations/Operating Requirements

The following discussion of financial obligations and operating requirements is organized based on recycled water system and, if applicable, agreements with others.

Palo Alto/Mountain View. The cities of Palo Alto and Mountain View entered into an agreement in 2007 regarding the use of recycled water from the Palo Alto RWQCP and other related provisions. The two parties agreed to share the facility design and construction costs to bring recycled water from the Palo Alto RWQCP to Mountain View.

As part of the agreement, the cities own the recycled water distribution systems within their respective service areas. Both parties have the right to approve or disapprove of water transfers from infrastructure within their service area and extending infrastructure within their service area, so long as the City of Mountain View does not exceed its allocated recycled water supply of 3 mgd (i.e., its maximum delivery rate). This agreement was amended in 2017, extending the agreement term to 2060.

Palo Alto/Mountain View – Valley Water. Palo Alto, Mountain View, and Valley Water executed an agreement effective December 10, 2019. The agreement defines a plan for Valley Water to provide $16 million toward the construction of the enhanced recycled water facility or “Local Plant” operated by Palo Alto or other possible alternatives to the Local Plant that still benefit RWQCP Partners; and effluent transfer volumes and payment for effluent used for a Valley Water-owned regional AWPF or “Regional Plant” located in Palo Alto or elsewhere in Santa Clara County.

Sunnyvale. The City of Sunnyvale does not have any known financial obligations for constructing its recycled water distribution system.

Sunnyvale – Valley Water. Valley Water and the City of Sunnyvale entered into agreements to construct the Wolfe Road Recycled Water project and guarantee its recycled water supply. Valley Water received the right to own the project facilities, wholesale recycled water from those facilities, and receive up to 1,095 acre-feet per year (AFY) of recycled water to resale, of which up to 500 AFY can be resold outside of Sunnyvale. The City of Sunnyvale operates and maintains the project facilities, including the San Lucar Recycled Water Pump Station (SLPS), but Valley Water owns those facilities. This agreement remains in force for a 10-year period beginning in 2014, then automatically renews for a 5-year term thereafter.

Sunnyvale – Cal Water. Cal Water owns, operates, and maintains the portions of the Sunnyvale distribution system that it constructed. There are no ongoing financial obligations associated with these projects, as they have been funded by implementing General Rate Cases adopted by the California Public Utilities Commission. Cal Water is responsible for all capital and operations and maintenance (O&M) costs associated with operating its facilities, as detailed in the wholesaler-retailer agreement between Cal Water and Valley Water.

SJ/SC RWF/SBWR. The March 2016 Report 16-05 titled South Bay Water Recycling: Better Information and Renegotiation of Contractual Obligations will Increase Transparency and Aid Program Success summarized the bonds and annual debt service obligations of the SBWR distribution system (Erickson 2016).

Sanitary sewer ratepayers from San José, Santa Clara, and all the tributary agencies (City of Milpitas, Cupertino Sanitary District, West Valley Sanitation District, County Sanitation District 2-3, and the Burbank Sanitary District) have paid for SBWR initial capital costs through sewer revenue bonds, loans, and cash contributions. Currently, there are two active bond series (2005A and 2009A) issued by the San José-Santa Clara Clean Water Financing Authority, and a loan from the State Revolving Loan Fund. Through fiscal year 2020–21, the cities of San José and Santa Clara and the tributary agencies are obligated to pay between $5M and $9M per year from wastewater facility revenues.

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SBWR is responsible for operating the recycled water production facilities that it owns and conveying recycled water to each of the four recycled water retailers. Recycled water is delivered to pipelines in each retailer's service area and turnouts to retailer-owned recycled water pipelines. Each retailer operates and maintains the distribution facilities in its service area, and SBWR reimburses the San José Municipal Water System, the City of Santa Clara, and the City of Milpitas for O&M costs. SJW also owns, operates, and maintains the recycled water distribution facilities that it owns. Wholesaler-retailer agreements also specify the quantities of recycled water that are available, as well as delivery limitations. SBWR is also responsible for recycled water quality and all regulatory permitting.

SBWR – Valley Water. As part of the agreement executed on January 22, 2002 between the City of San José and Valley Water regarding managing and operating the SBWR system, Valley Water paid to upsize the 30-inch-diameter Silver Creek Pipeline to bring recycled water to Coyote Valley and the Metcalf Energy Center. In exchange for paying for the upsized pipeline, Valley Water received the rights to use and/or wholesale at a minimum 5 mgd of recycled water (approximately 3,500 gallons per minute [gpm]) from this pipeline. Valley Water has been considering opportunities to use this supply for a potential indirect potable reuse (IPR) project. The term of this agreement remains in effect through 2027.

SBWR and Valley Water also executed the Recycled Water Facilities and Programs Integration Agreement in 2010. Among its financial obligations, CSJ and Valley Water shall consider any recommendation tendered by the Recycled Water Policy Advisory Committee on their proposed budgets to maintain, expand, replace, improve and operate SBWR and SVAWPC. While SVAWPC is operational, the agreement also includes operational support payments relating to the net operating cost of SBWR and SVAWPC. The term of this agreement runs through June 30, 2050.

SBWR – SJW. SJW owns, operates, and maintains the portions of the SBWR distribution system that it has constructed. There are no ongoing financial obligations as a result of these projects, as they were funded through implementing General Rate Cases adopted by the California Public Utilities Commission. SJW is responsible for all capital and O&M costs associated with operating its facilities, as detailed in the two wholesaler-retailer agreement amendments between the City of San José and SJW.

SCRWA – Valley Water. In 1999, Valley Water, the cities of Gilroy and Morgan Hill, and SCRWA entered partnership agreements with SCRWA as the producer, Valley Water as wholesaler, and the cities of Gilroy and Morgan Hill as retailers to develop a recycled water project. Since that time, Valley Water and SCRWA have completed several improvements to the distribution system and SCRWA treatment plant to increase recycled water use. A portion of those improvements were funded by federal grants, with the remainder covered by Valley Water and SCRWA.

The existing South County recycled water distribution system is operated by Valley Water (in coordination with the City of Gilroy) and has no known financial obligations that impact future recycled water expansion within this service area.

1.4 Recycled Water Demands

Recycled water demands have steadily increased over the years until the most recent drought period of 2013–2016. Since then, recycled water demands have slightly decreased. Recycled water demands are expected to stay steady or slightly increase as additional customers receive recycled water by retrofit, redevelopment, or construction of new infrastructure.

Current (2015) and projected (2020–2040) demands were adapted from each retailer's 2015 Urban Water Management Plan (UWMP) within each recycled water retailer's service area. For the PA/MV, Sunnyvale, and SCRWA systems, recycled water demands are projected to stabilize by 2030, while SBWR demands are projected to steadily rise through 2040. Table 1-2 summarizes current and projected recycled water

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demands from the 2015 UWMPs (potable and non-potable) for each retailer, with subtotals for each producer and a countywide total. Note–some Partner Agencies are in the process of updating their demand projections (to be incorporated into the Master Plan if and when available).

Table 1-2. Current and Projected Recycled Water Demands from 2015 UWMPs

Producer	Retailer	Demand (AFY)[a]					
		2015	2020	2025	2030	2035	2040
PA/MV RWQCP	City of Palo Alto[b]	818	1,750	1,750	1,750	1,750	1,750
PA/MV RWQCP	City of Mountain View	450	995	1,091	1,091	1,091	1,091
PA/MV RWQCP subtotal		1,268	2,745	2,841	2,841	2,841	2,841
Sunnyvale WPCP	City of Sunnyvale	717	1,236	1,306	1,419	1,419	1,419
Sunnyvale WPCP	Cal Water	0	220	261	261	261	261
Sunnyvale WPCP subtotal		717	1,456	1,567	1,680	1,680	1,680
SJ/SC RWF (SBWR)	City of Milpitas	856	1,150	1,995	2,207	2,470	2,686
SJ/SC RWF (SBWR)	City of Santa Clara	3,529	4,700	5,700	6,100	6,500	6,900
SJ/SC RWF (SBWR)	San José Municipal Water System	3,607	5,117	5,638	6,187	6,764	7,368
SJ/SC RWF (SBWR)	SJW[c]	1,964	4,073	6,853	8,351	8,369	8,369
SJ/SC RWF (SBWR) subtotal		9,956	15,039	20,186	22,845	24,103	25,324
SCRWA WWTP	City of Gilroy[b]	1,995	2,563	3,130	3,698	3,698	3,698
SCRWA WWTP	City of Morgan Hill	0	0	0	0	0	0
SCRWA WWTP subtotal		1,995	2,563	3,130	3,698	3,698	3,698
County total		13,936	21,803	27,725	31,065	32,323	33,543

Source: (Retailer 2015 UWMPs)

a. Demands include both potable and non-potable use.

b. City of Palo Alto and City of Gilroy demands include recycled water used at the RWQCP and WWTP, respectively (e.g., for in-plant processes or irrigation).

c. SJW demands assume all planned extensions (Alignments D, E, Q, P, L, and K) are constructed.

1.5 System Performance and Challenges

This section describes the condition and performance of each treatment facility and the associated distribution system, including age, capacity, reliability, and O&M considerations. This section also summarizes existing system deficiencies and challenges.

1.5.1 Treatment Facilities

Recent flows, design flows, and recycled water production capacity are summarized in Table 1-3. More detailed descriptions of each treatment facility are included below.

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Table 1-3. Treatment Facility Flows and Recycled Water Production

Facility	Average Inflow (mgd)[a]	Design ADWF (mgd)	Design PWWF (mgd)	Recycled Water Production Capacity (mgd)
PA/MV RWQCP	19.9	39.0	80.0	4.5
Sunnyvale WPCP	11.8[b]	29.5	40.0	4.0[c]
SJ/SC RWF (SBWR)[c]	99.0	167.0	271.0	38.0
SCRWA WWTP	6.5	8.5	N/A	9.0
SVAWPC [d]	5.7	N/A	N/A	8.0

a. Average inflows are from 2015-2017, from the California Integrated Water Quality System (CIWQS) database.

b. Per Sunnyvale staff, influent values reported to CIWQS were reduced by 0.5 mgd to more accurately report the flow entering the plant.

c. Sunnyvale WPCP production capacity assumes completion of Continuous Recycled Water Production Facilities project (expected late 2020).

d. SJ/SC RWF recycled water production is currently limited by filtration capacity.

e. SVAWPC produces purified water

ADWF = average dry weather flow

PWWF = peak wet weather flow

PA/MV RWQCP. The cities of Mountain View and Los Altos retired their WWTPs in 1968 and agreed to expand at the current site of the Palo Alto RWQCP to serve the growing local area. The RWQCP was completed in 1972 as a secondary treatment plant, with subsequent upgrades adding fixed-film reactors and dual-media filters (1980), more secondary clarifiers (1988), and ultraviolet (UV) disinfection (2010). The current treatment design capacity is 39 mgd for average dry weather flow and 80 mgd for peak wet weather flow. The RWQCP's coarse sand filter/chlorine disinfection train can produce up to 4.5 mgd of recycled water.

Based on the City of Palo Alto's 2012 Long Range Facilities Plan, much of the equipment at the RWQCP is approaching the end of its useful life and will require major rehabilitation or replacement (City of Palo Alto 2012). Replacing the solids incinerator is a high priority due to reliability and seismic vulnerability, though a new headworks and additional recycled water facilities (e.g., pumping, storage, filtration, and chlorine disinfection) are also primary concerns. New regulations—especially regarding nitrogen removal—may also require additional facility upgrades.

Sunnyvale WPCP. Originally constructed in 1956 as a primary treatment facility with a 7.5-mgd design capacity, the Sunnyvale WPCP has since added secondary (e.g., air flotation tanks, fixed-growth reactors, oxidation ponds) and tertiary (e.g., dual-media filters, chlorination) capabilities while expanding its capacity to 29.5 mgd ADWF and 40.0 mgd PWWF.

The City of Sunnyvale is in the process of implementing WPCP upgrades to allow for continuous production of recycled water. Previously, recycled water could only be produced in batches, which was inefficient and unreliable. These upgrades isolate recycled water treatment and allow simultaneous recycled water production and effluent discharge to the San Francisco Bay (SF Bay). Construction should be complete by late 2020, which will increase recycled water production capacity to 4 mgd.

According to the City of Sunnyvale's 2013 WPCP Master Plan, priority improvements include replacing primary treatment facilities (currently in construction), rehabilitating secondary and tertiary facilities, and converting secondary treatment to a conventional activated sludge process (City of Sunnyvale 2013a). These projects are scheduled to be constructed through 2037.

SJ/SC RWF/SBWR. Completed in 1956, SJ/SC RWF began as a 36-mgd WWTP for the City of San José and became a regional facility in 1959, when the City partnered with the City of Santa Clara. Over the next

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decade, other sewer districts and tributary partners joined, triggering expansion for both operations and to buffer the community from light, noise, chemicals, and odors. SJ/SC RWF has a design capacity of 167 mgd for ADWF and 271 mgd for PWWF. Recycled water production is limited by the filtration system capacity, approximately 38 mgd. Up to 8 mgd of this supply can originate from SVAWPC, while the remainder is conveyed through the SJ/SC RWF filtration building and effluent diversion pipeline to the transmission pump station (TPS) wet well.

The 2013 Plant Master Plan is the key planning guide for SJ/SC RWF improvements through 2040 (SBWR 2013). In addition to identifying and prioritizing $2.2B in future upgrades, the Plant Master Plan designates future SJ/SC RWF land uses and examines protection strategies for sea level rise. Repairs have already begun on the electrical distribution system and solids digestion. Other immediate-term (through 2020) projects include headworks modifications and upgrades to primary and secondary treatment, filtration, and sludge thickening.

SVAWPC. SVAWPC opened in 2014 to improve the quality of recycled water produced at the SJ/SC RWF and to serve as a demonstration facility for advanced water purification treatment. Using microfiltration (MF), reverse osmosis (RO), and UV disinfection, SVAWPC produces up to 8 mgd of effluent that is low in total dissolved solids (TDS), sodium, silica, and organic matter, while complying with the Title 22 non-potable requirements for tertiary disinfected effluents. When blended with the tertiary disinfected recycled water from SBWR, it decreases the salinity (targeting 500 milligrams per liter [mg/L] of TDS) and improves the quality of the blended flow that allows for a wider variety of irrigation, commercial, and industrial end uses. The feedwater to SVAWPC is secondary effluent from SJ/SC RWF.

SCRWA WWTP. The WWTP was built in 1990 to serve the cities of Gilroy and Morgan Hill and has an ADWF secondary treatment capacity of 8.5 mgd. SCRWA is currently in process of designing a modular expansion of its WWTP to add approximately 2.5 mgd of membrane bioreactors to produce tertiary effluent.

SCRWA's 2011 Capital Improvements Strategic Plan (CISP) prioritizes replacing emergency backup generators and installing a second influent force main (SCRWA 2011). Other improvements identified in the CISP (a UV disinfection facility, a third secondary clarifier, aeration system redundancy, additional pre-anoxic basins, and improved facility communications) have either been completed or are currently in construction.

1.5.2 Distribution System Infrastructure

This section reviews each recycled water distribution system (e.g., pump stations, storage tanks, and pipelines) in terms of capacity, condition, and reliability. Any significant O&M concerns are also discussed.

PA/MV. Palo Alto and Mountain View are each responsible for operating and maintaining facilities within their respective city limits. The PA/MV distribution system features a 0.5-million-gallon (MG) storage tank and a 6.24-mgd pump station that was originally constructed in 1980 along with pipelines to supply Shoreline Golf Course in Mountain View. The supply pipeline was extended in 1987 to serve additional customers in Mountain View, but its failure in 2001 temporarily suspended recycled water use in Mountain View. Subsequently, a new recycled water pipeline was constructed in 2009 to serve the North Bayshore area of Mountain View.

Hydraulic analysis of the recycled water distribution system conducted as part of the City of Mountain View's 2014 Recycled Water Feasibility Study did not identify significant deficiencies within Mountain View; however, the Shoreline Golf Course recycled water irrigation system requires significant improvements, including pipe and possibly pump replacement. No other major issues are known for the Palo Alto pipeline network, though reliability is a concern because the system lacks a potable water backup supply or significant storage.

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Sunnyvale. The WPCP recycled water pump station was completed in 1994 and modified in 2000 to increase its total capacity to 8 mgd. Actual pumping rates (roughly 6.5 mgd) depend on the system pressure set at the San Lucar storage tank pressure sustaining valve. Total system storage is 2.0 MG, comprising the 1.5-MG San Lucar storage tank and a 0.5-MG surge tank on the same site. Sunnyvale's portion of the recycled water distribution system was built between 1992 and 2000, and the San Lucar tank and pump station (7.9 mgd firm capacity) were constructed in 2000.

Overall, the Sunnyvale recycled water system is very reliable, with potable water backups at the WPCP pump station and the San Lucar tank, and the ability to feed the entire system from the SLPS. Valley Water recently upgraded SLPS to create a second pressure zone and supply the Wolfe Road recycled water pipeline. The SLPS pumps flow both south into the Wolfe Road recycled water pipeline and north to the rest of the Sunnyvale recycled water distribution system.

SBWR. The SBWR distribution system was constructed in the late 1990s and early 2000s. The TPS can deliver up to a firm capacity of 40.0 mgd of recycled water, which can be stored in three tanks (combined storage capacity of 9.6 MG) in the distribution system. A 2010 Condition Assessment concluded that the system is generally well-maintained and in good condition, but some facilities, including communications, valves, and TPS pumps and electrical components, are nearing the end of their useful lives.

As peak hour recycled water demands approach distribution system capacity, recycled water production requires high manual control and planning, which strains staff resources and compromises reliability. The single backbone pipeline also poses a vulnerability. Though each municipality (City of San José, City of Santa Clara, and City of Milpitas) is responsible for maintaining facilities within their limits (and SJW maintains the facilities it owns), staffing is further stretched due to long distances between isolation valves, which reduces operational flexibility and potentially increases system outages.

SJW is responsible for O&M of the recycled water pipelines it constructed and owns that are part of the SBWR distribution system. All the SJW-owned infrastructure has been constructed since 2010 and is expected to be in good condition.

The 2014 SBWR Strategic and Master Planning study identified NPR opportunities for each retailer (SBWR 2014). Within each service area, increased use by customers along existing pipelines, redevelopment, and conversion of selected customers to recycled water is expected to continue. Near-term recycled water use was expected to represent up to 3,900 AFY of additional demand by 2020. The projection reflects a contractual commitment to supply up to 1,200 AFY to SJW for extensions within the SJW service area.

SCRWA. The SCRWA system was originally constructed in the late 1970s, with new facilities (pipelines, pump stations, and a closed tank reservoir) added around 2000. Recycled water from the WWTP feeds a 3-MG reservoir. Two on-site pump stations draw from the storage reservoir. Pump Station 93 (6-mgd capacity) supplies the pipeline system north of the WWTP, while Pump Station 94 (5.2-mgd capacity) feeds the southern system. The northern system also has a 1.5-MG storage tank, for 4.5 MG of total storage.

The City of Gilroy operates and maintains the distribution system in partnership with Valley Water. Redundancy from system storage protects against treatment disruptions, but pumping is vulnerable because Pump Station 94 operates above its firm capacity. There are plans to add a new pump, such that both pump stations operate within firm capacity.

1.5.3 System Deficiencies

Each system faces extensive upgrades due to aging equipment, increased flows/loads, and/or more stringent regulations. Table 1-4 lists the more specific and unique challenges for each system.

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Table 1-4. Recycled Water System Deficiencies

System	Quantity	Water Quality	Reliability
PA/MV	N/A	• High salinity	• Insufficient storage • No potable water backup
Sunnyvale	N/A	• High salinity • Recycled water has greenish tint	• Insufficient storage • Recycled water production highly manual
SBWR	• Peak hour demands approaching system capacity	N/A	• Insufficient distribution system storage • Lack of isolation valves
SCRWA	N/A	• High salinity	• No potable water backup

N/A = not applicable

Across all four systems, some recycled water infrastructure is nearing the end of its useful life and requires significant rehabilitation and replacement. Further, treatment plant operators may need to replace newer, functioning equipment as they anticipate future regulations (e.g., nutrient removal). These capital improvement projects will further stretch budgets and personnel, who need to balance day-to-day operation with planning, design, and construction efforts.

Planned capital improvements are further discussed in Section 3.2.2.

Section 2: Potable Reuse Research and Planning

Valley Water has undertaken several research efforts to evaluate IPR through GWR (groundwater spreading or injection) and direct potable reuse (DPR) as additional sources of water supply with the following goals:

- Demonstrate compliance with the regulatory requirements for GWR at both pilot and full scale
- Evaluate alternatives to upgrade the UV disinfection system to an advanced oxidation process (AOP)
- Evaluate ozone with biologically active filtration (BAF) to spread GWR and in DPR
- Educate stakeholders on SVAWPC's ability to create high-quality water for PR

Valley Water's Expedited Purified Water Program evaluated several options for PR. Through this effort, Valley Water identified a recommended alternative that involves (1) delivering at least 24 mgd (24,000 AFY) of full advanced treatment (FAT) (i.e., MF, RO, and an AOP) water by 2025 from a new facility or from an expanded SVAWPC to the Los Gatos Ponds for groundwater spreading (Valley Water 2018) and (2) future expansion to supply up to 45,000 AFY of PR. The recommended alternative, however, may change based on this Master Plan's outcomes.

2.1 Full-Scale Performance Testing

Valley Water performed testing during a 12- to 18-month period to evaluate the ability of a FAT train to comply with GWR regulations (2016 PR Demonstration Test Plan). The testing looked at both the performance of individual unit processes as well as an overall water quality analysis. Over the course of the testing period, a high degree of treatment performance was demonstrated for each of the unit processes, as described below (Valley Water 2016).

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2.1.1 Microfiltration

MF performance was evaluated at full scale using both typical performance surrogates (e.g., turbidity, membrane integrity testing) and water quality testing. The test results showed a high degree of removal of bacteria, protozoa, and particulate matter.

2.1.2 Reverse Osmosis

In addition to measuring typical performance surrogates (e.g., electroconductivity and total organic carbon [TOC]), Valley Water used full-scale challenge testing to demonstrate greater than 3-log removal of virus under baseline conditions and 2-log removal under compromised conditions (i.e., with intentional damages to the RO membrane integrity (Valley Water 2016). The removal of electroconductivity and TOC were both consistently lower than the observed virus removal, making these conservative surrogates for full-scale RO monitoring.

2.1.3 UV Treatment

Because SVAWPC was originally intended to improve the quality of recycled water produced at the SJ/SC RWF, the UV system was designed to meet Title 22 disinfection requirements. There was not an explicit goal to also achieve the higher UV doses needed for AOPs described in the groundwater injection regulations. Consequently, additional work was performed to evaluate the minimum design criteria for a future UV/AOP system (Valley Water 2016). An extensive suite of chemicals was evaluated during the testing, with only one constituent—N-nitrosodimethylamine (NDMA)—exceeding the health-based thresholds. NDMA is one of two constituents that drives sizing of the UV system. A future UV/AOP system is anticipated to provide an additional barrier to reduce the concentration of NDMA below the notification level of 10 nanograms per liter (ng/L).

2.1.4 Monitoring

Throughout testing, Valley Water evaluated the performance of the treatment barriers using a variety of surrogate parameters. These data will be used to select the monitoring parameters used to confirm treatment compliance toward the required 12/10/10 pathogen reduction goals for PR. The testing also revealed challenges of using different surrogates and identified issues that will need to be addressed at full scale, such as the appropriate selection and maintenance of UV transmittance meters for the UV/AOP system.

2.1.5 Water Quality

Water quality testing demonstrated compliance with the full suite of criteria, including regulated contaminants, nutrients, and contaminants of emerging concern (CECs); the only exception was exceedances in NDMA. This was anticipated based on the lack of a high-dose UV/AOP system, a known issue with the existing treatment train. Valley Water's 2016 PR Demonstration Test Plan included pilot UV/AOP studies.

2.2 Pilot UV/AOP Testing

Valley Water tested a pilot UV/AOP system using Wedeco LBX90 UV reactors capable of providing the high UV doses needed to drive AOP reactions. The testing included validation of the reactor at different conditions and evaluation of surrogate monitoring methods. Through testing, Valley Water demonstrated that the requirement for 0.5-log reduction of 1,4-dioxane can be achieved through a UV dose of 800 millijoules per square centimeter with 6 mg/L of hydrogen peroxide (H_2O_2) (Valley Water 2016). The testing also shows that use of an alternative oxidant (hypochlorite) does not provide the same performance.

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2.3 Pilot Ozone/BAF Testing

A pilot ozone/BAF system was used to evaluate two potential future scenarios: (1) production of a tertiary filtered water for groundwater spreading, and (2) pretreatment for a future RO-based DPR treatment train (see Figure 2-1). In the context of groundwater spreading, ozone/BAF can further reduce TOC (in the range of 20 to 40 percent) while providing protection against pathogens and a wide range of chemical contaminants. Adding ozone/BAF has also been evaluated as a potential pathway to DPR when coupled with FAT (State Water Resources Control Board 2016; Pecson et al. 2017). The pilot testing evaluated performance using both tertiary and secondary feedwaters to simulate groundwater spreading and DPR treatment trains, respectively, as described below.

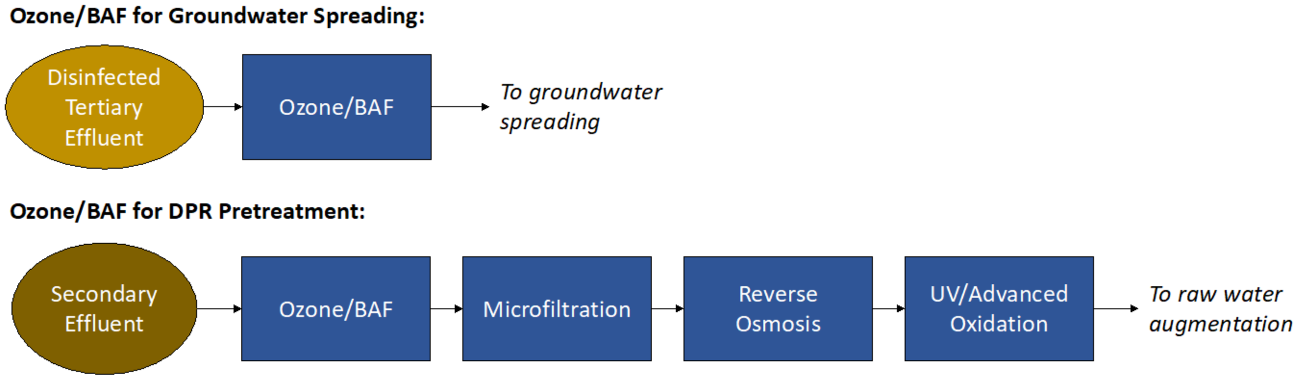
Ozone/BAF for Groundwater Spreading:
Disinfected Tertiary Effluent
Ozone/BAF
To groundwater spreading
Ozone/BAF for DPR Pretreatment:
Secondary Effluent
Ozone/BAF
Microfiltration
Reverse Osmosis
UV/Advanced Oxidation
To raw water augmentation

Figure 2-1. Treatment trains investigated with ozone/BAF piloting

2.3.1 Ozone/BAF for Groundwater Spreading

Valley Water decided in 2017 to use FAT treatment for GWR options to protect the quality of the groundwater basin. At the same time, Valley Water has committed to periodically reviewing the technologies used for GWR. Along these lines, Valley Water evaluated a non-RO based treatment option for groundwater spreading that involved using ozone and BAF treatment. To move forward with this option, additional considerations include compliance with the Santa Clara Basin Salt and Nutrient Management Plan, antidegradation analysis, and public outreach efforts.

To test the technical feasibility of this treatment option, tertiary feedwater was fed to the O3/BAF pilot to mimic a future groundwater spreading project. Testing evaluated the ability of ozone/BAF to reduce TOC, CECs, and total nitrogen (Valley Water 2016). The goal was to demonstrate whether upstream ozone/BAF could reduce the level of soil aquifer treatment (SAT) required and potentially allow for greater project capacity. One key parameter was TOC because it limits the maximum fraction of recycled water that can contribute to the groundwater. Testing evaluated a range of both ozone dose (i.e., the ozone-to-TOC ratio) and BAF empty bed contact times to maximize TOC and CEC destruction while minimizing costs.

Operational challenges that arose were related to: (a) ozone control, (b) TOC reduction, (c) nutrient compliance, and (d) NDMA control. Over the course of testing, it was difficult to control ozone dosing, a problem that may have been caused by the presence of chlorine in the ozone feedwater. TOC removal through the pilot was lower than anticipated (roughly 20 versus 40 percent), which may have resulted from the residual chlorine affecting the biological populations on the BAF. Consequently, the testing did not confirm whether the ozone/BAF can provide sufficient TOC reduction to pursue spreading. The Valley Water team recommended additional soil column testing to further explore this option (Valley Water 2016).

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Another challenge was that total nitrogen levels could not be reduced below the 10 mg/L requirement for GWR. This was largely due to the presence of nitrate, for which there are no barriers in the tertiary treatment train (filtration and disinfection). Remedying this will require modifications to the secondary process (e.g., additional biological denitrification) or additional subsequent treatment barriers (e.g., denitrifying filters or ion exchange).

The water quality testing included several groups of chemical contaminants, including both regulated and unregulated chemicals. One of the most challenging chemicals to control was NDMA. The feedwater itself had elevated NDMA levels (in excess of 200 ng/L at times) with ozone increasing these levels by up to an additional 50 ng/L. BAF was able to reduce the NDMA concentrations to 120 to 180 ng/L, though additional attenuation through SAT would be required to comply with the 10 ng/L notification level. SAT's ability to provide this protection must be confirmed through soil column or full-scale testing.

2.3.2 Ozone/BAF as Pretreatment for DPR

Valley Water also evaluated ozone/BAF as pretreatment to a FAT train in a potential DPR scenario. The testing demonstrated 25 percent reduction of TOC in the secondary feedwater. NDMA was less prevalent in the secondary effluent compared to the tertiary effluent, with levels in the 50 to 60 ng/L range. Ozone/BAF effluents contained NDMA in the 19 to 33 ng/L range, which is above the 10 ng/L notification level, but well within the range of values that can be treated downstream by UV/AOP. While nitrate was a challenge for groundwater spreading, it will not be a concern for injection because the RO will likely reduce these levels below the 10 mg/L limit. The high degree of CEC reduction was in line with the findings from the tertiary effluent. Challenge testing with an indicator virus (MS2 coliphage) showed greater than 5-log inactivation with ozone-to-TOC ratios of 0.6 and higher.

Although Valley Water's pilot testing demonstrated that ozone/BAF could be an effective water purification strategy, a comparison of alternatives in Valley Water's Expedited Purified Water Program Plan led them to recommend an IPR scenario that includes FAT for groundwater spreading. Ozone/BAF scenarios may still be considered for future projects, subject to additional site-specific analysis.

2.4 Groundwater Conditions

Groundwater is a highly important resource in the County, supplying nearly half the county's water in some years. The groundwater basin operational storage capacity is over twice that of the local reservoirs, and the basins comply with Basin Plan Objectives. Several studies are underway to evaluate the potential impact of IPR, including groundwater modeling, groundwater monitoring, and dissolution studies (Mohr 2017).

2.4.1 Groundwater Modeling

Valley Water has updated its groundwater flow model to simulate potential IPR scenarios (Todd Groundwater 2017b). One critical aspect of this modeling was determining the retention time provided in the aquifer, because this value can impact project feasibility, capacity, and treatment required. The modeling evaluated GWR through both spreading and injection.

A numerical groundwater flow model was used to simulate changes in groundwater levels and flow under various IPR scenarios: percolation at the existing Los Gatos Ponds, injection into potable supply aquifers using new wells north of the Los Gatos ponds, and percolation at/near the Ford Pond site. The model was used to model horizontal travel times to nearby potable supply wells. For both the Los Gatos Ponds and injection well scenarios, more than 2 years of travel time was estimated between the spreading site and downgradient water supply wells. Shorter retention times were observed at the Ford Ponds (1 to 12 months) with several municipal wells located within 6-months' travel time. To determine compliance with the regulatory requirements for response retention time, modeled travel times must be divided by two, i.e., a 1-

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year modeled travel time would represent a retention time of 6 months for regulatory permitting purposes. Based on these results, the use of the Los Gatos Ponds is expected to comply with the retention time requirements of the GWR regulations.

2.4.2 Groundwater Monitoring

Valley Water has constructed several groundwater monitoring wells located 2 weeks to 6 months downgradient of the potential IPR facilities (Todd Groundwater, 2017c). The wells allow for water quality sampling at multiple depths and provided soil cores used for the dissolution studies.

2.4.3 Dissolution Studies

Dissolution studies were conducted to determine if FAT water used for IPR could react with aquifer sediments to cause the dissolution or leaching of metals into groundwater (Todd Groundwater, 2017a). Test conditions were developed with the dual objectives of protecting the purified water transmission piping and fittings from corrosion and preventing dissolution of harmful constituents from aquifer materials into groundwater (HDR, 2017).

Two rounds of soil testing were conducted, using samples from both the Ford Ponds and Los Gatos Ponds. Dissolution testing provided strong evidence that interaction of buffered purified water and aquifer sediments will not result in significant leaching of metals to groundwater. Specific water quality recommendations for the purified recycled water were also developed as a result of the testing.

2.5 Independent Advisory Panel Engagement

Since 2013, Valley Water has engaged the National Water Research Institute as part of an Independent Advisory Panel (IAP) to provide third-party, science-based review of PR as a potential future water supply option. To date, Valley Water has held five annual IAP meetings to help Valley Water staff and local policymakers make informed decisions about future PR applications for Valley Water’s service area. After each meeting, the IAP issues a panel report that includes a concise list of findings and recommendations. The gap analysis (see Section 4) includes the recommendations from the most recent IAP Panel Report (Crook et al. 2017).

Section 3: Expanded Reuse Opportunities and Considerations

Valley Water is exploring opportunities to expand water reuse throughout the County. This section provides a preliminary assessment of the volume of water available for reuse, a summary of planned and potential interties and CIP projects, and other considerations for expanding NPR and introducing PR.

3.1 Preliminary Assessment of Volume Available and NPR/PR Split

Before exploring conceptual and feasible water reuse alternatives, Valley Water analyzed current and projected conditions at each of the four recycled water producers in the County to estimate the approximate volume of water available for reuse.

3.1.1 Volume Available

Valley Water requested data from the Palo Alto RWQCP, Sunnyvale WPCP, SJ/SC RWF, and SCRWA WWTP to establish current conditions and projected future conditions to determine the potential volume available for NPR and PR. Current monthly averages and annual projections were collected for the following flows:

- Plant influent

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- Evaporation and/or other losses (e.g., in-plant process losses)
- Required flow for environmental benefit
- NPR demands (including recycled water used at the Palo Alto RWQCP and SCRWA WWTP)
- Plant effluent (current only)

Using this information, a flow balance was created to determine the remaining effluent available for discharge, blending, or additional reuse (see Figure 3-1). In an ideal situation, the volume available for reuse (both NPR and PR) will equal the plant influent less losses (e.g., evaporation and in-plant process losses) and other flow requirements (e.g., for environmental benefits), and the volume available as source water for PR will equal the total volume available less the NPR demands. Treatment processes to produce purified water for PR do not result in 100 percent recovery; thus, some of the available source water for PR will be rejected in the ROC stream or may be used to dilute the ROC for discharge, depending on the findings of the ROC management study (refer to Section 3.1.3 on ROC management).

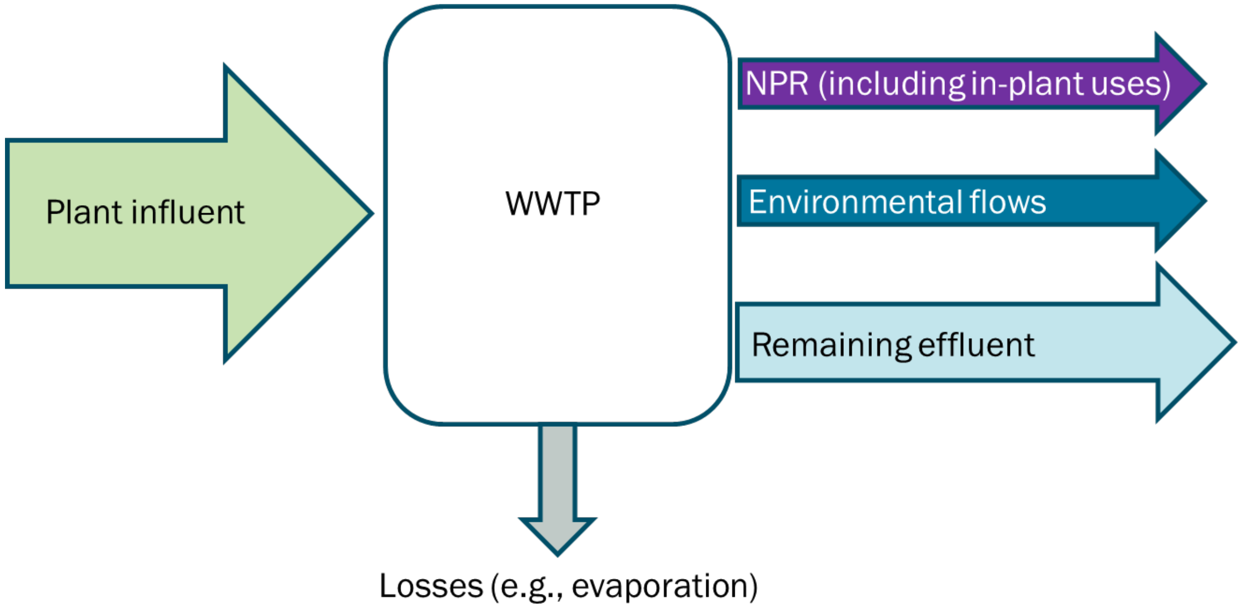

Figure 3-1. Example flow streams were identified to establish the baseline condition

3.1.1.1 Baseline (Current) Conditions

This section provides details on plant influent, outflow streams, internal WWTP NPR, and monthly distribution factors.

Plant Influent. To summarize current conditions, monthly influent flow data for each of the four WWTPs during 2015 (a critically dry year), 2016 (a below normal to dry year), and 2017 (a wet year) were collected from the CIWQS database. These flow data were then used to calculate the ADWF (i.e., the lowest consecutive 3-month average). To capture seasonal variation, monthly distribution factors were calculated by dividing the average flow for each month by the ADWF; these factors were then multiplied by future ADWF projections to develop monthly distribution curves. Monthly plant effluent data were also collected from the CIWQS database to backcheck the water balance.

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Plant Outflow Streams. Flow streams leaving the plant include evaporative losses, waste removal, flows for environmental benefits, recycled water delivered to offsite customers, and WWTP discharge to the SF Bay:

- Average monthly evaporative losses, typically between 1 and 2 mgd, were identified for the Sunnyvale WPCP, associated with the use of its current ponds as a part of its treatment process[2]. The Palo Alto RWQCP recirculates some effluent for in-plant uses (e.g., wet scrubber water and filter backwash), and experiences a 20 percent loss of the recirculated flow (an average of about 0.3 mgd). Palo Alto also uses some recycled water for in-plant processes and landscape irrigation around the Palo Alto RWQCP; however, these flows are included in the NPR demands, as described in the 2015 UWMP. No evaporation or other losses were identified for the SJ/SC RWF or SCRWA WWTP.
- State Water Resources Control Board tentative and adopted orders for recycled water use and National Pollutant Discharge Elimination System (NPDES) permits for each facility were reviewed to identify existing minimum flows for environmental benefit. The Renzel Marsh project for the Palo Alto RWQCP, with an average current flow of 1 mgd, was the only environmental benefit project identified in these documents.
- Flow data for NPR production and/or deliveries were collected from the four WWTPs and converted to monthly averages across the same time frame (2015–17[3]). These data do not necessarily include the contractually obligated flows discussed in Section 1.3.2. For example, the City of Palo Alto is contractually obligated to provide up to 3 mgd (instantaneous basis) of recycled water to the City of Mountain View, but current actual NPR demands are much lower. To capture seasonal variation, monthly distribution factors were calculated by dividing the monthly average recycled water production by the annual average. These factors were multiplied by future annual NPR projections to develop monthly distribution curves.
- The monthly plant effluent data for flows discharged to the environment (including flows required for environmental benefit) were collected from the CIWQS database.

From this information, the baseline condition was established. The monthly distribution factors for influent and NPR demand were used in the next step to estimate projected future conditions. The process for synthesizing this information is illustrated in Figure 3-2.

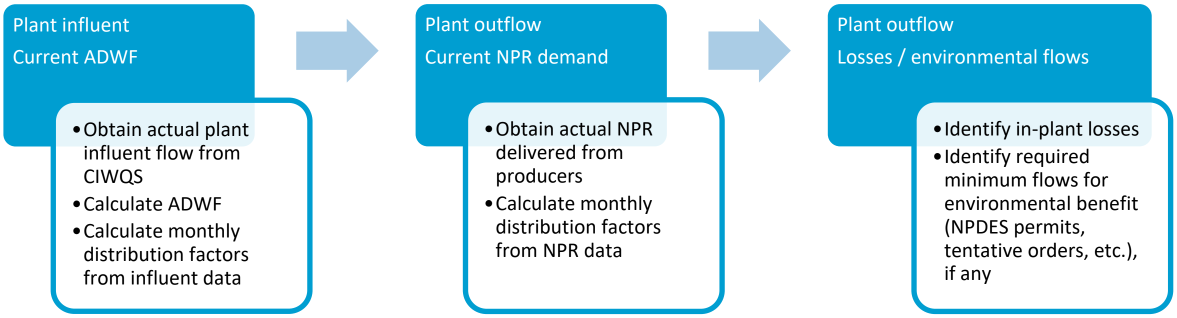
Plant influent
Current ADWF
•Obtain actual plant influent flow from CIWQS
•Calculate ADWF
•Calculate monthly distribution factors from influent data
Plant outflow
Current NPR demand
•Obtain actual NPR delivered from producers
•Calculate monthly distribution factors from NPR data
Plant outflow
Losses / environmental flows
•Identify in-plant losses
•Identify required minimum flows for environmental benefit (NPDES permits, tentative orders, etc.), if any

Figure 3-2. Process for analyzing existing data and establishing the baseline condition

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[2] Current Sunnyvale WPCP evaporative loss data was received from Sunnyvale WPCP staff.

[3] NPR volumes from Sunnyvale WPCP were only available for 2015–16.

Internal WWTP NPR. Some facilities produce recycled water for internal treatment plant uses, such as washdown water. The in-plant recycled water is typically discharged within the treatment plant (e.g., to the headworks of the WWTP) and thus does not affect the volume entering or exiting the plant; however, recycled water for some on-site uses (e.g., irrigation) may reduce the amount available to meet other NPR demands.

For this evaluation, Valley Water used NPR demand projections from the retailers' 2015 UWMPs, which include uses of recycled water at the Palo Alto RWQCP[4] and SCRWA WWTP. To be conservative, these in-plant flows were considered part of the projected NPR demand and unavailable for additional reuse. Figure 3-3 demonstrates the in-plant uses as a portion of total NPR demand reported for 2015.

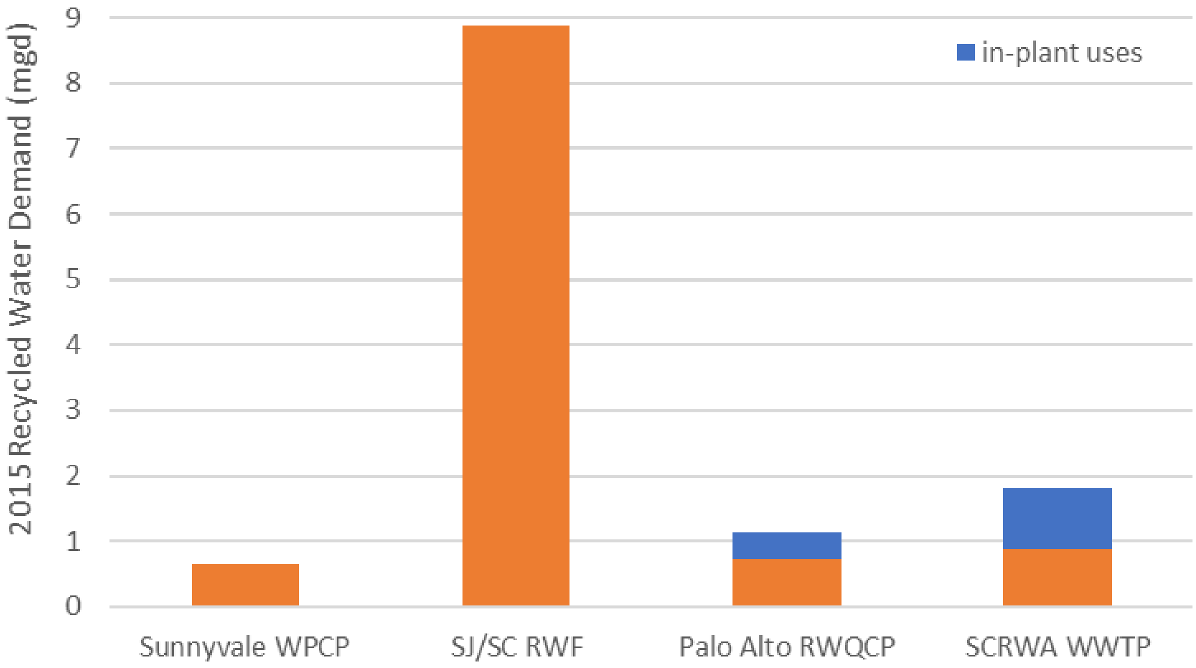

Figure 3-3. 2015 recycled water demand, as presented in 2015 UWMPs

Monthly Distribution Factors. Current plant influent and the resulting monthly distribution factors (based on ADWF) are summarized in Table 3-1. The current NPR demand from each facility and the resulting monthly distribution factors (based on average NPR demand) are summarized in Table 3-2. Future flow projections for plant influent and NPR demand are presented on the basis of ADWF and average NPR demand, respectively, and can be multiplied by these distribution factors to determine the monthly variation in projected influent and NPR demand.

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[4] Per Palo Alto's 2015 UWMP, both recycled water and final effluent are used for processes at the RWQCP; however, only the recycled water portion is included in the NPR demands. In-plant process losses of effluent (approximately 0.3 mgd) are considered separately.

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Table 3-1. Current Flows: Plant Influent (mgd) and Monthly Distribution Factors								
	Sunnyvale WPCP [a]		SJ/SC RWF		Palo Alto RWQCP		SCRWA WWTP	
Month	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)	Plant Influent (2015–2017 average)	Monthly Distribution Factor (ADWF)
Jan.	13.3	1.2	104.6	1.1	22.3	1.2	7.1	1.2
Feb.	14.1	1.3	108.0	1.1	24.3	1.4	8.0	1.3
March	13.3	1.2	104.5	1.1	22.6	1.3	7.5	1.3
April	12.3	1.1	99.4	1.0	21.1	1.2	6.9	1.2
May	11.7	1.1	97.6	1.0	20.4	1.1	6.4	1.1
June	11.4	1.1	97.2	1.0	19.9	1.1	6.1	1.0
July	11.1	1.0	94.2	1.0	18.2	1.0	6.0	1.0
Aug.	11.1	1.0	97.9	1.0	17.9	1.0	6.0	1.0
Sep.	10.7	1.0	97.1	1.0	17.5	1.0	6.0	1.0
Oct.	10.9	1.0	98.0	1.0	18.1	1.0	6.0	1.0
Nov.	11.3	1.0	96.6	1.0	18.5	1.0	6.0	1.0
Dec.	11.1	1.0	95.0	1.0	18.0	1.0	6.0	1.0
ADWF	10.9		96.3		17.8		6.0	

a. *The Sunnyvale WPCP influent that is reported to CIWQS includes, on average, 0.5 mgd of internal plant recycle (as clarified by Sunnyvale staff) and does not reflect actual flow coming into the plant. Thus, the Sunnyvale influent numbers, as reported to CIWQS, were reduced by 0.5 mgd to more accurately report the flow entering the plant.*

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Table 3-2. Current Demands: NPR Demand (mgd) and Monthly Distribution Factors for Each Plant

	Sunnyvale WPCP		San José/Santa Clara RWF		Palo Alto RWQCP		SCRWA WWTP	
Month	NPR demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)	NPR Demand (2015–2017 average)	Monthly Distribution Factor (average NPR demand)
Jan.	0.4	0.4	6.7	0.6	0.1	0.2	1.2	0.7
Feb.	0.4	0.5	6.5	0.5	0.2	0.3	1.0	0.5
March	0.6	0.7	7.4	0.6	0.3	0.4	1.4	0.8
April	0.9	1.0	9.6	0.8	0.5	0.9	1.7	0.9
May	1.2	1.3	13.6	1.1	0.9	1.4	2.0	1.1
June	1.5	1.7	17.9	1.5	1.0	1.7	2.6	1.4
July	1.4	1.6	19.5	1.6	1.1	1.8	2.8	1.5
Aug.	1.5	1.7	19.0	1.6	1.2	2.0	2.9	1.6
Sep.	1.4	1.5	17.2	1.4	1.0	1.6	2.2	1.2
Oct.	0.9	1.0	14.3	1.2	0.7	1.1	1.9	1.0
Nov.	0.3	0.4	7.4	0.6	0.2	0.4	1.3	0.7
Dec.	0.2	0.2	5.9	0.5	0.2	0.3	1.2	0.6
Average NPR Demand	0.9		12.1		0.6		1.9	

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3.1.1.2 Projected Conditions

To develop future estimates for plant influent and recycled water demand, various planning documents from multiple agencies were reviewed. As the Master Plan progresses, estimates may be refined if more recent data and/or projections become available.

Plant Influent. Individual recycled water master plans provided the basis for plant influent flow rates. These plans included projections for ADWF (i.e., the lowest consecutive 3-month average). Actual ADWF for 2015–2017 was lower than projected in the plant recycled water master plans, likely due to short-term conservation savings and long-term water use reductions implemented during the drought. Therefore, the ADWF projection curves were adjusted to reflect the lower trends as informed by actual 2015–2017 ADWF. For example, Figure 3-4 shows how the projection curve was shifted to account for 2015–2017 actual ADWF into the PA/MV RWQCP. The plant influent monthly distribution factors calculated from current data were applied to the single ADWF values for future years to estimate the monthly distribution of expected plant influent (e.g., more flow in the winter months, less influent in the summer), along with average annual flows.

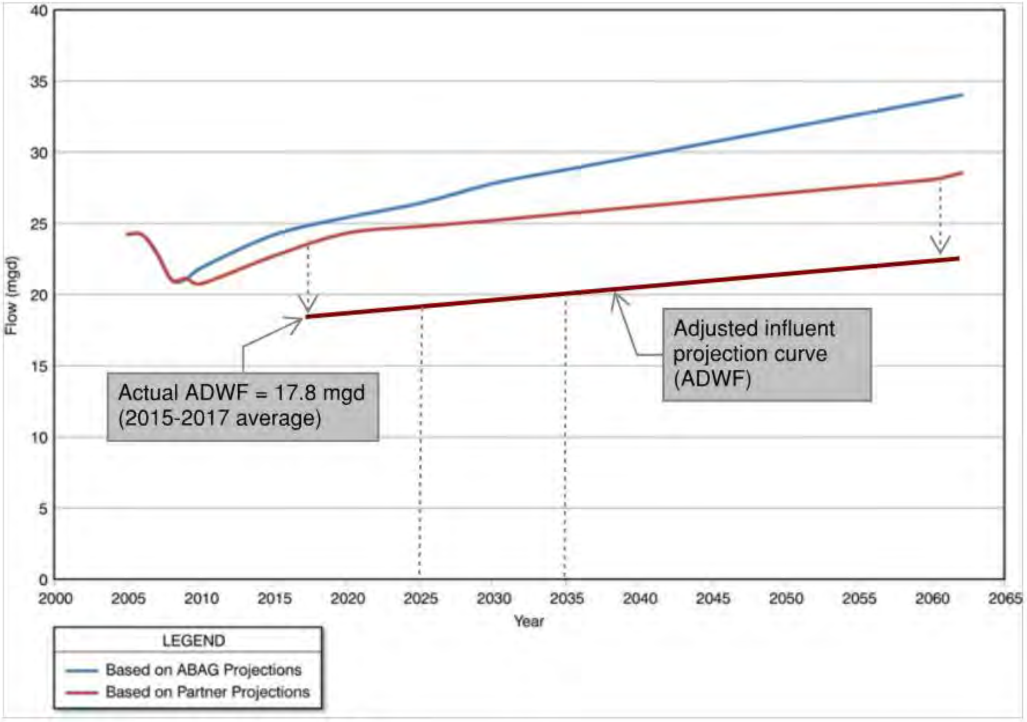

Figure 3-4. ADWF projections from the PA/MV RWQCP Long Range Facilities Plan, adjusted for current flows

Source: (City of Palo Alto 2012).

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Plant Outflow Streams. Plant effluent streams were estimated as follows:

- Based on input from the City of Sunnyvale, future average losses at the Sunnyvale WPCP associated with its pond system are assumed to be 4 mgd, including flows for capping, evaporation, and other losses. Sunnyvale WPCP is expected to be in split-flow conventional activated sludge configuration in 2025, and full conventional activated sludge by 2035. However, a minimum of 4 mgd must be sent to the ponds to maintain a viable microbial community in 2025, and there is no plan identified for the ponds in 2035; therefore, the flow analysis considers both the current evaporative losses and the potential future average losses of 4 mgd through 2035.
- The Renzel Marsh project for Palo Alto RWQCP was the only environmental benefit project assumed for future estimates. Renzel Marsh is currently designed to receive 1 mgd; however, based on input from Palo Alto staff, Palo Alto is considering a potential expansion, which would accept 3 mgd. The flow analysis considers current average flow (1 mgd) as well as an average future flow of 3 mgd. In addition, the flow analysis includes a 0.3-mgd loss to account for the 20 percent loss of recirculated effluent used for in-plant processes (e.g., wet scrubber water and filter backwash), per Palo Alto's 2015 UWMP.
- Recycled water demand estimates (including recycled water used at the Palo Alto RWQCP and SCRWA WWTP) were obtained from individual retailers' UWMPs. The years 2025 and 2035 overlapped for all four WWTPs, so these 2 years were used to estimate potential water available for reuse in the future. The recycled water demand monthly distribution factors calculated from current data were applied to the projected recycled water demands for future years to estimate monthly distribution of expected recycled water demand (e.g., more demand in the summer months, less demand in the winter). Some of the partner agencies, including the City of Palo Alto, are currently in the process of updating their demand projections. These updated projections may be incorporated into the final Master Plan.

The remaining effluent—which provides an estimate of potential volume available for discharge, blending, or as feed water for an AWPF—was calculated for each facility by subtracting the plant outflow streams from the plant influent in 2025 and 2035. The process used to develop these estimates is illustrated on Figure 3-5.

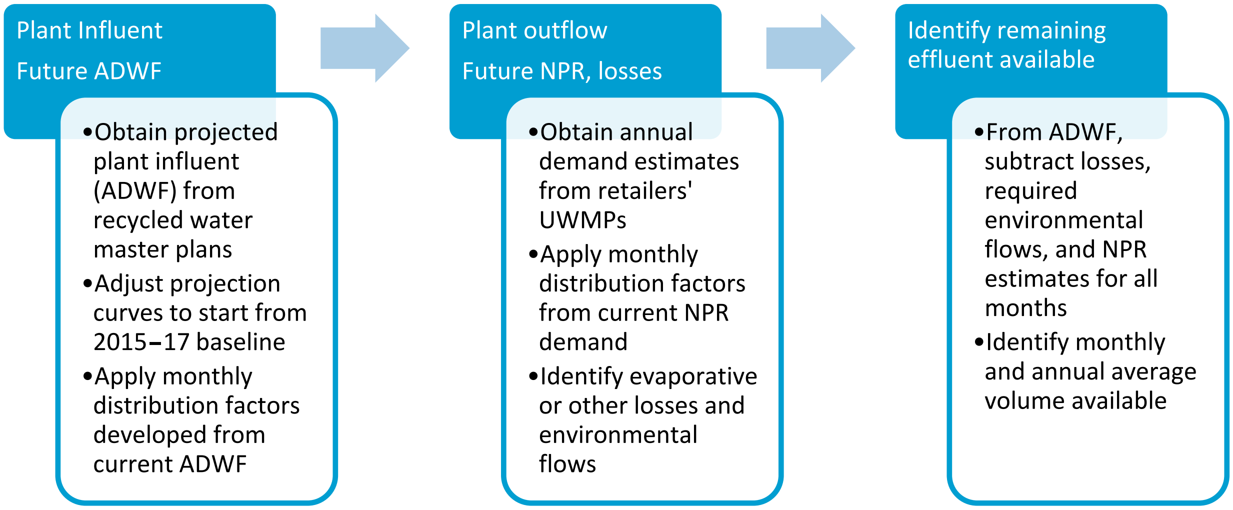
Plant Influent
Future ADWF
•Obtain projected plant influent (ADWF) from recycled water master plans
•Adjust projection curves to start from 2015–17 baseline
•Apply monthly distribution factors developed from current ADWF
Plant outflow
Future NPR, losses
•Obtain annual demand estimates from retailers' UWMPs
•Apply monthly distribution factors from current NPR demand
•Identify evaporative or other losses and environmental flows
Identify remaining effluent available
•From ADWF, subtract losses, required environmental flows, and NPR estimates for all months
•Identify monthly and annual average volume available

Figure 3-5. Process used to estimate remaining effluent available for discharge, blending, or as AWPF feed

Flows Available for Additional Reuse. Based on the analysis above, the remaining effluent available for discharge, blending, or additional reuse (above and beyond the 2015 UWMP demand projections by retailers, as shown in Table 1-2) was calculated; annual averages are summarized in Table 3-3 for the years 2025 and 2035. Annual average flows may not be available year-round, particularly in the summer months. Furthermore, some agencies have contractual agreements restricting the use of certain flows, as discussed in Section 1.3.2. For example, the City of Palo Alto is contractually obligated to provide up to 3 mgd (instantaneous basis) of recycled water to City of Mountain View. That is, the City of Palo Alto does not have the rights to allocate that supply to other uses, which effectively reduces the calculated flow available to allocate/wholesale to Valley Water in all months. The remainder of the 3 mgd not used by the City of Mountain View is potentially available for Valley Water to use during most months of the year, but it would require that Valley Water acquire rights to that water. Flow estimates will be refined throughout the Master Plan as new information becomes available.

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Table 3-3. Preliminary Estimates of Effluent Remaining for Discharge, Blending, or Additional Reuse (Beyond Existing Plans for NPR) in 2025 and 2035

Partner Agency	Available Influent, mgd (AFY)[a]	NPR Demands, mgd (AFY)	Losses/Environmental Flows, mgd (AFY)	Remaining Effluent, mgd (AFY)[b]	Current Contractual Obligation[c]
2025					
Palo Alto RWQCP	21.0 (23,400)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	15.2-17.2 (16,900–19,200)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	14.6 (16,300)	1.4 (1,600)	1.4-4.0[e] (1,600–4,500)	9.2-11.8 (10,300-13,200)	See footnote (f).
SJ/SC RWF	103.2 (115,600)	18.1 (20,300)	0	85.1 (95,300)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	2.8 (3,100)	0	3.7 (4,200)	N/A
Total, 2025[g]	**145.3 (162,700)**	**24.8 (27,900)**	**2.7-7.3 (3,000-8,200)**	**113.2–117.8 (126,700-131,800)**	
2035					
Palo Alto RWQCP	22.1 (24,700)	2.5 (2,800)	1.3-3.3[d] (1,500–3,700)	16.3-18.3 (18,200–20,400)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale WPCP	17.3 (19,400)	1.5 (1,700)	1.4-4.0[e] 1,600–4,500	11.8-14.4 (13,200-16,100)	See footnote (f).
SJ/SC RWF	107.4 (120,200)	21.5 (24,200)	0	85.9 (96,000)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA WWTP	6.5 (7,300)	3.3 (3,700)	0	3.2 (3,600)	N/A
Total, 2035[g]	**153.3 (171,600)**	**28.8 (32,400)**	**2.7-7.3 (3,000-8,200)**	**117.2-121.8 (131,000-136,200)**	

a. *Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies.*

b. *Calculated as available influent less the sum of 2015 UWMP NPR demand estimates, environmental flows, and other losses (such as in-plant process water losses).*

c. *Projected NPR demands do not fully capture potential allocations per contractual agreements. New agreements may be needed to access portion of available effluent for additional reuse. Governance considerations will be further evaluated as the Master Plan progresses.*

d. *Range reflects flow to Renzel Marsh currently included in the NPDES permit (1 mgd) and a high estimate (3 mgd), in case of a future expansion, along with an estimated 0.3-mgd loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).*

e. *Range reflects current evaporation rates and higher estimate reserved for evaporation, capping, and other losses.*

f. *Per agreement between Sunnyvale and Valley Water, Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits. Valley Water and Sunnyvale meet annually to discuss the anticipated quantity of recycled water to be delivered through the Wolfe Road Pipeline to Valley Water customers.*

g. *Difference due to rounding.*

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3.1.2 NPR/PR Split

Section 3.1.1 summarizes future plant influent, losses, environmental flow requirements, NPR demands, and the remaining effluent available (i.e., plant influent minus losses, environmental flows, and NPR demands). As discussed above, a portion of these flows are contractually obligated; making these flows available for countywide use would require new agreements. For the purpose of determining the reasonably available volume (based on projected usage), this analysis assumes NPR demands align with projections in the 2015 UWMPs. Governance considerations and potential new agreements will be further evaluated as the Master Plan progresses.

Flows available for additional reuse can be allocated as source water for either PR or additional NPR, or a combination of both. To estimate an initial NPR/PR split, NPR demands are assumed to increase per the future annual estimates in the 2015 UWMP prepared by each retailer, applied over the course of 1 year in accordance with the monthly distribution factors described in Table 3-2. Any remaining flows (minus potential flow required for discharge or blending) will be available as source water for PR (i.e., feed water for an AWPF). Examples of how this calculation presents the monthly flow for NPR and remaining effluent available from each treatment plant are presented on Figures 3-6 through 3-11. The average remaining effluent was identified for each facility, though this flow may not be available year-round. Additionally, flow projections may be further refined as new information (e.g., updated NPR demand projections) becomes available.

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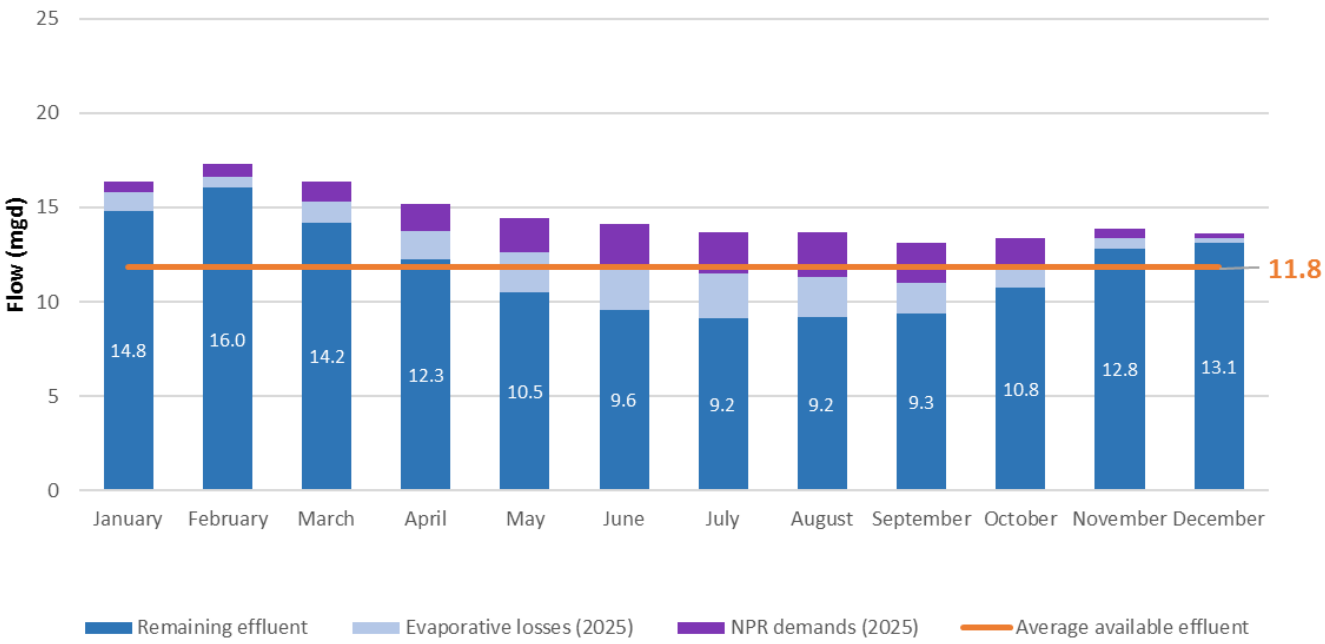

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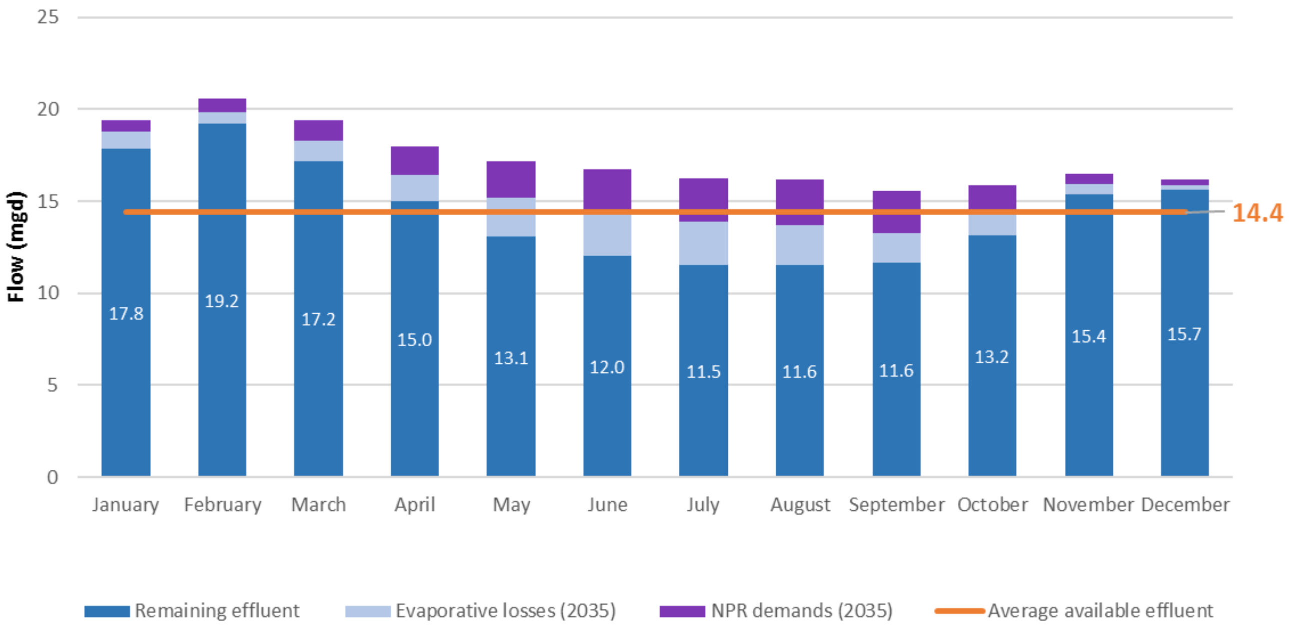

(b)

Figure 3-6. Sunnyvale WPCP: average plant influent, categorized by NPR demands, evaporative losses (based on current evaporation rates), and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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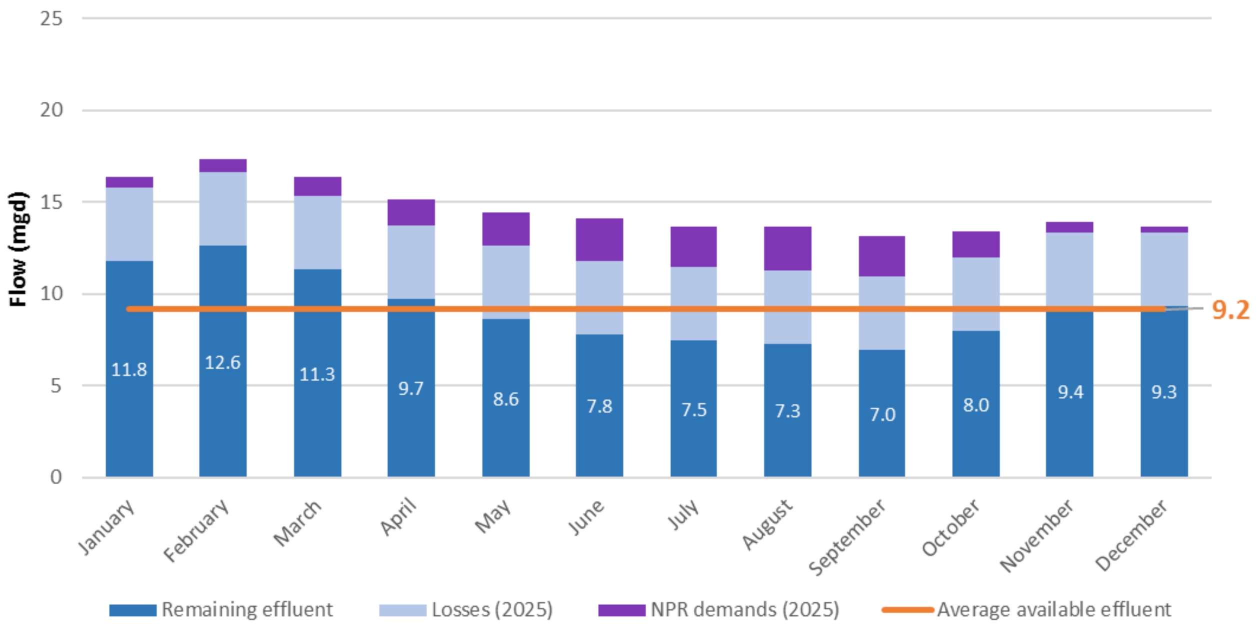

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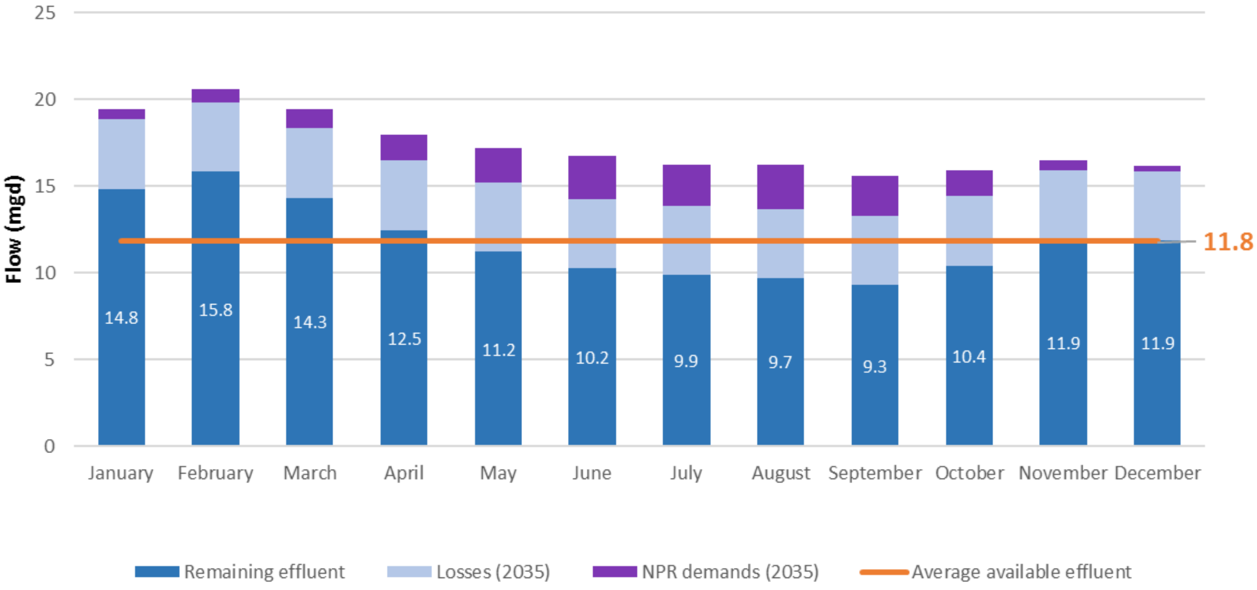

(b)

Figure 3-7. Sunnyvale WPCP: average plant influent, categorized by NPR demands, 4 mgd of evaporative and other losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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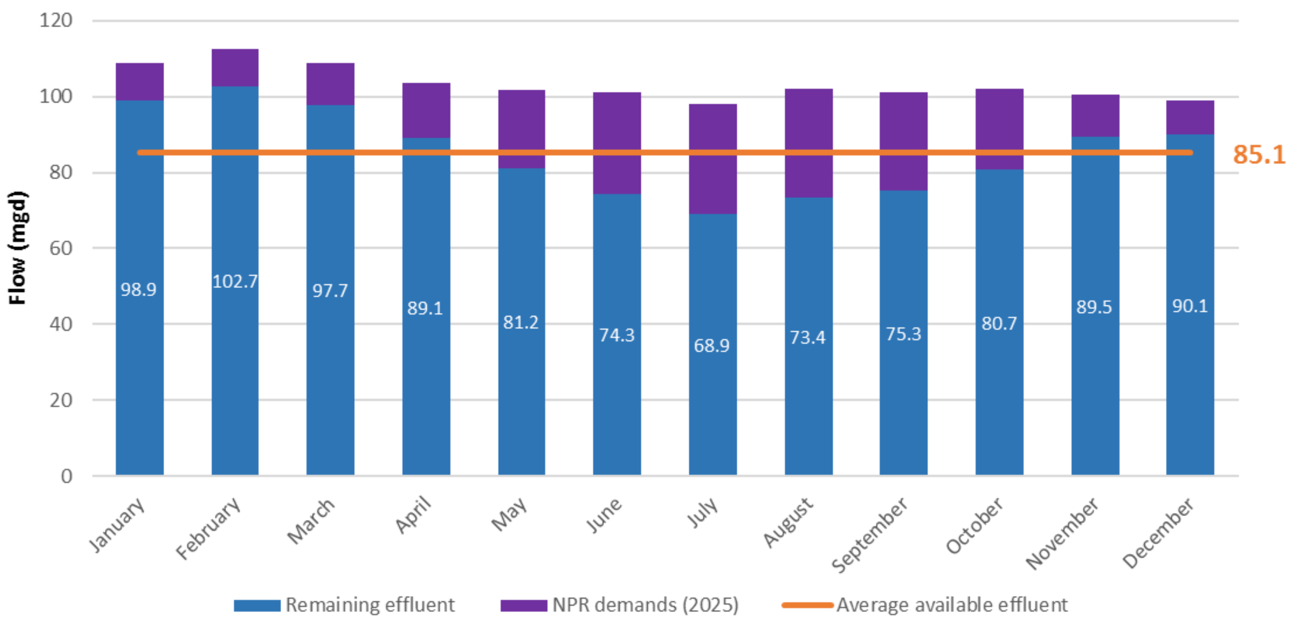

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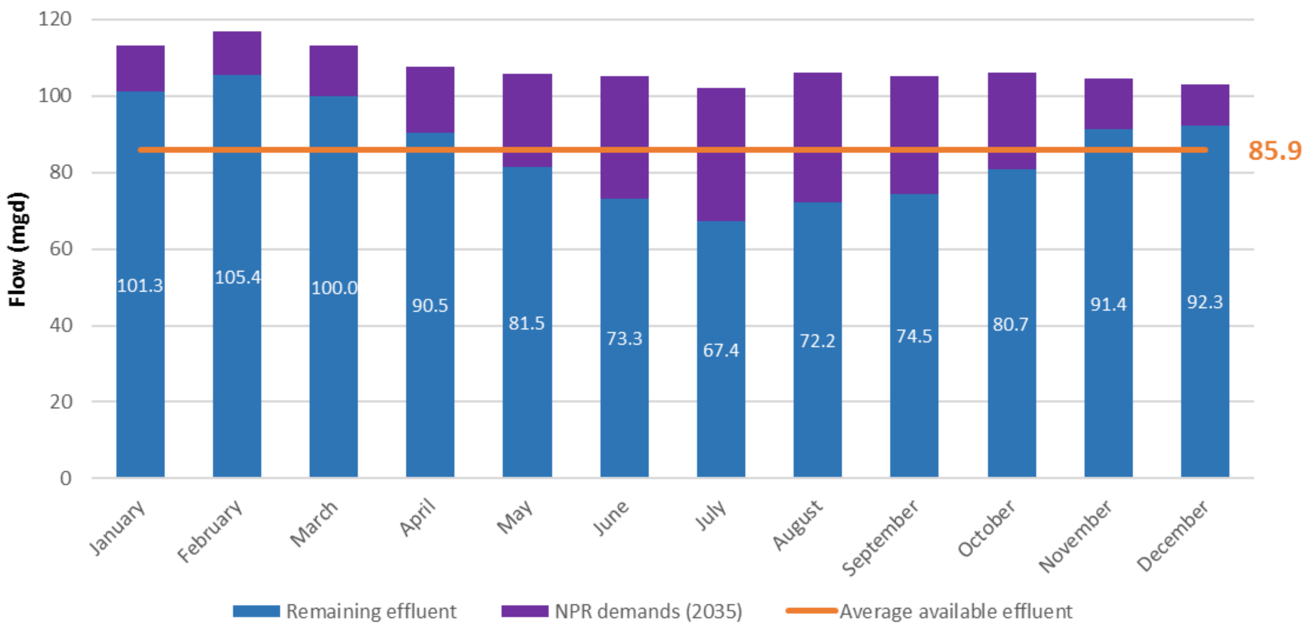

(b)

Figure 3-8. SJ/SC RWF: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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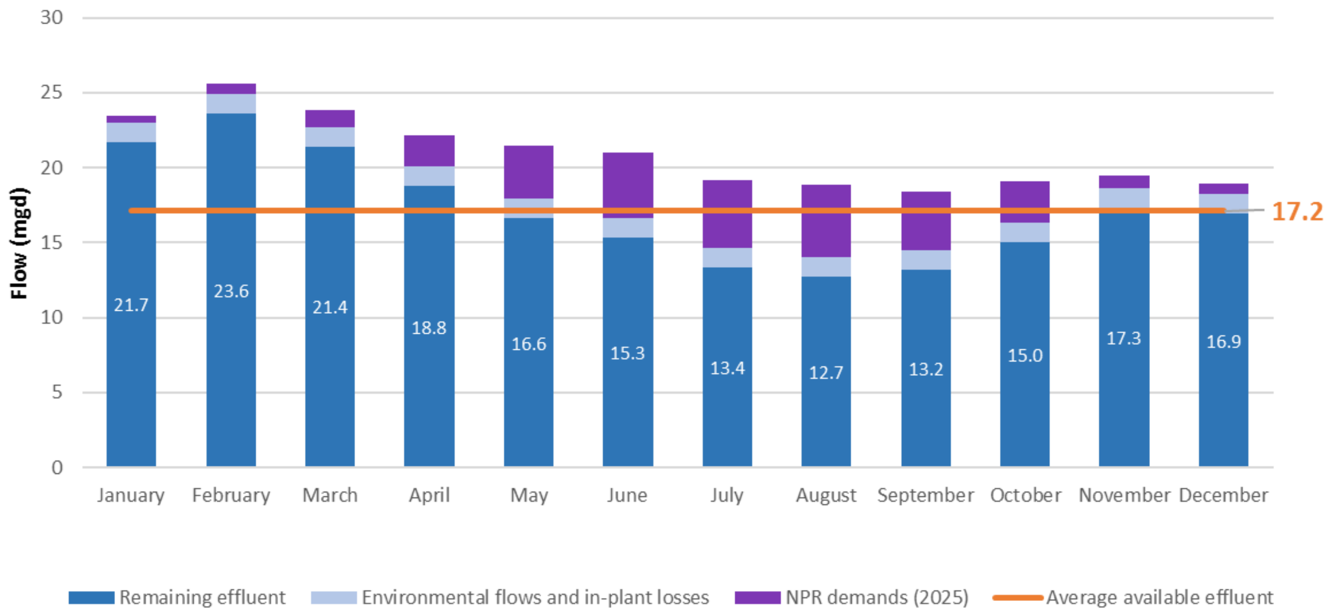

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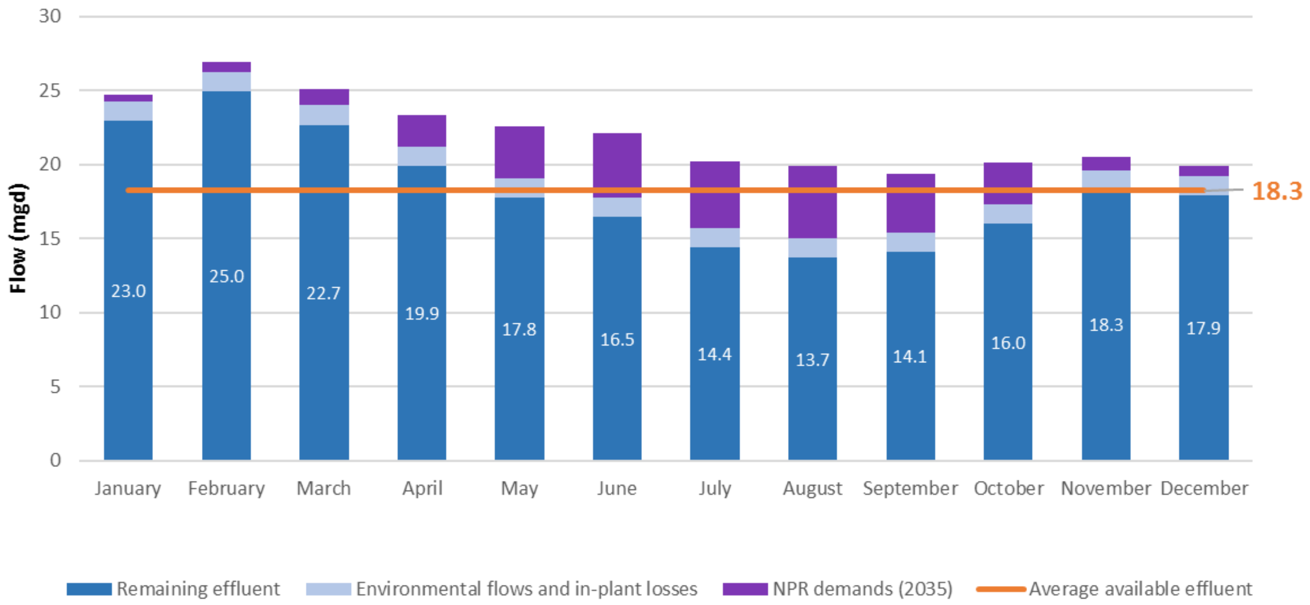

(b)

Figure 3-9. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 1 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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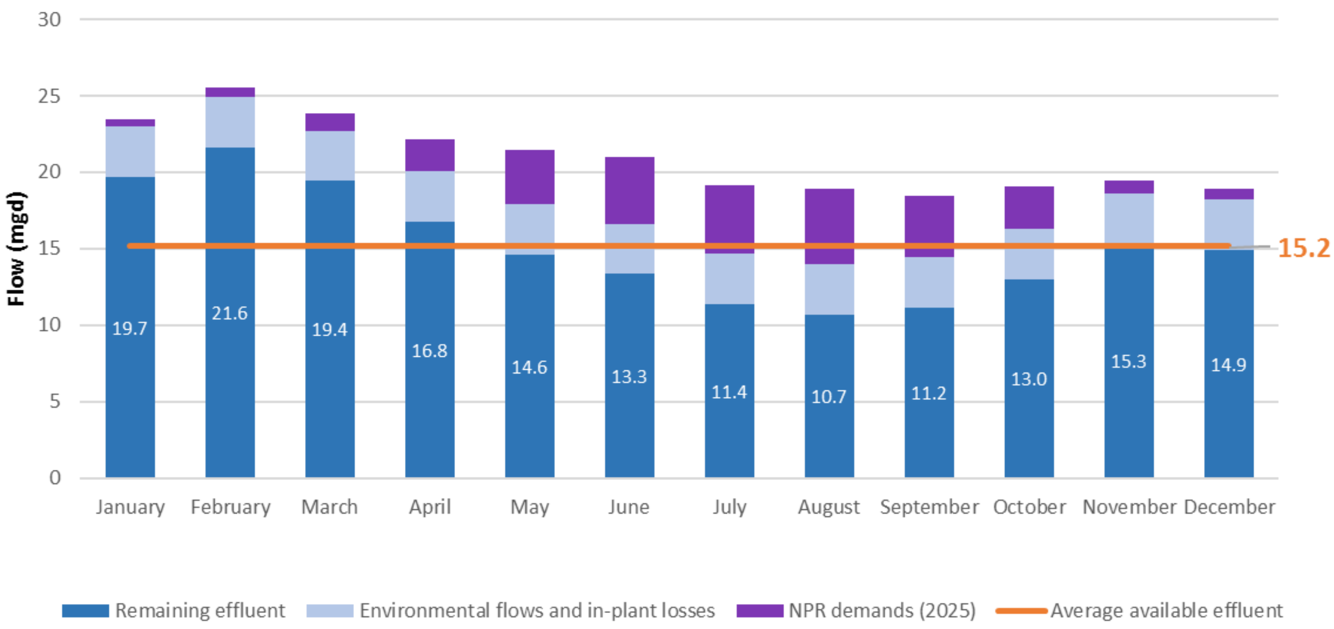

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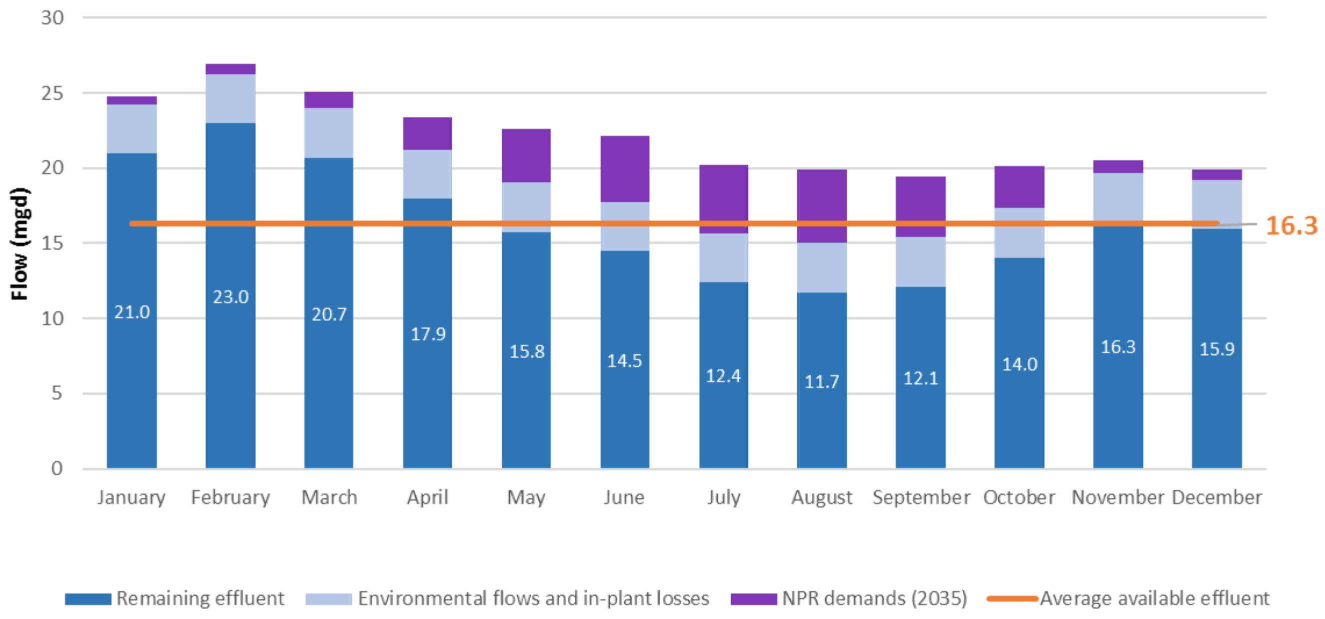

(b)

Figure 3-10. Palo Alto RWQCP: average plant influent, categorized by NPR demands, 3 mgd to Renzel Marsh, in-plant process water losses, and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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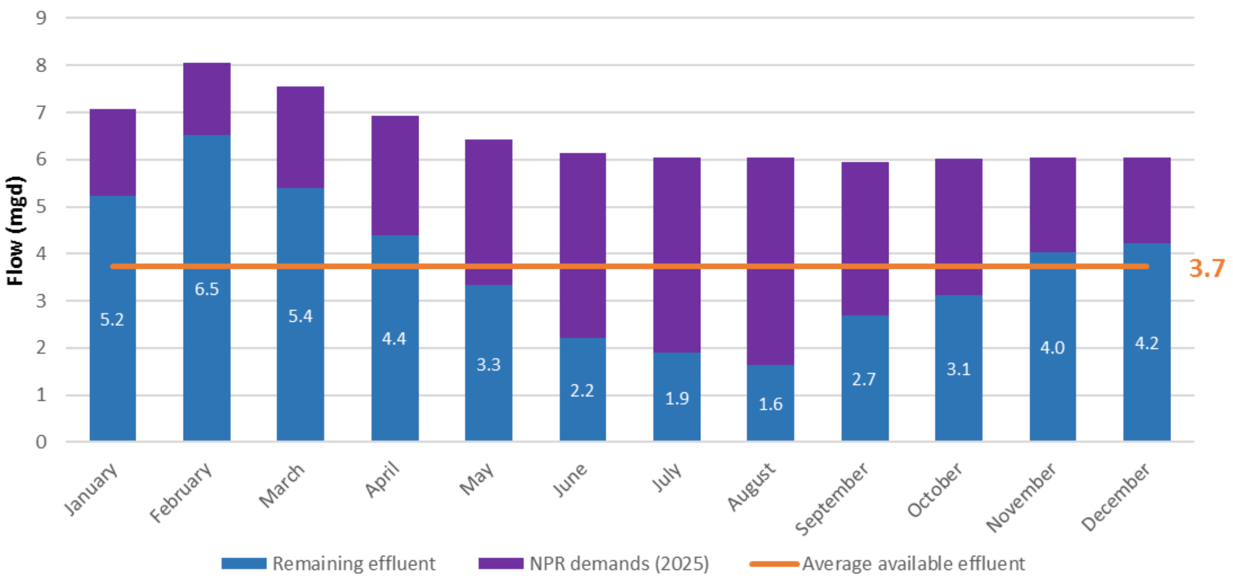

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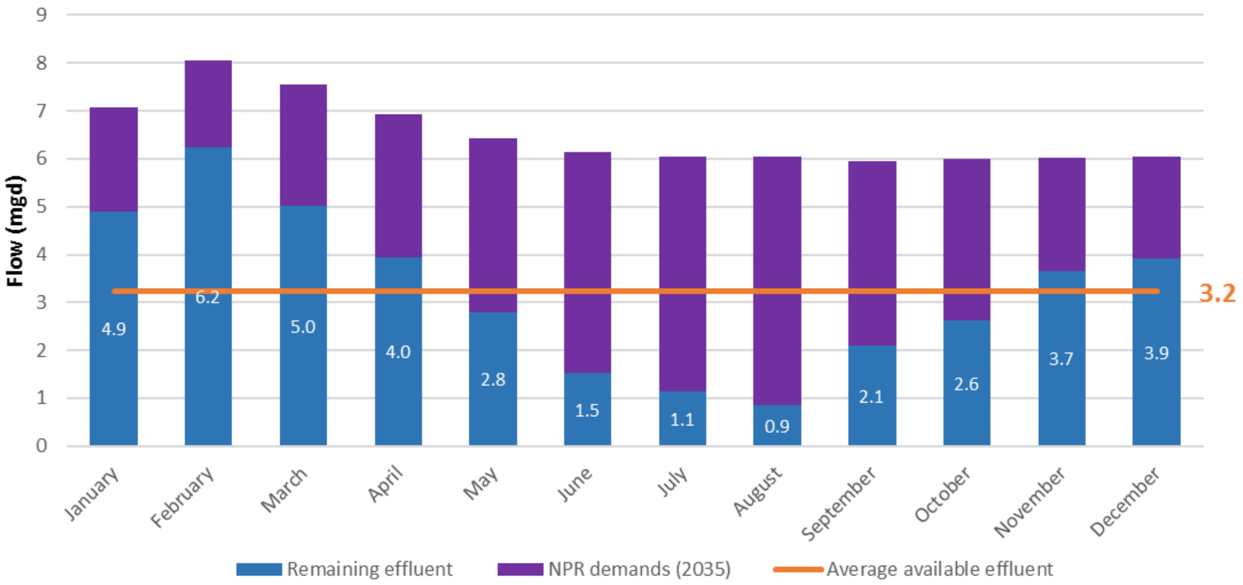

(b)

Figure 3-11. SCRWA WWTP: average plant influent, categorized by NPR demands and remaining effluent available for discharge, blending, or AWPF feed in (a) 2025 and (b) 2035

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3.1.3 ROC Management Considerations

PR options that use RO-based treatment trains must manage ROC streams. Currently, the ROC from the 8-mgd SVAWPC is managed through the City of San José's outfall. If Valley Water expands RO-based treatment for PR, the increased ROC flows will present new challenges.

Currently, Valley Water is evaluating options for ROC management at the SVAWPC and at four other potential locations. ROC management options for the five locations were selected through a multi-criteria analysis method based on the following types of considerations: environmental, social, cost, engineering, and regulatory (Valley Water 2017a). In evaluating the options, copper, cyanide, nickel, and selenium were identified as the key water quality constituents for compliance.

The ROC management plan document also evaluated several past studies in the literature review, including reports on chronic toxicity and mass balance of the constituents of concern for NPDES compliance (Valley Water 2017a). The toxicity study found potential toxicity issues at higher ROC blend ratios (40 to 48 percent) and recommended additional testing to develop a larger baseline data set. The mass balance study identified several options to pursue if compliance became an issue, including:

- Reduce SVAWPC ROC production rates at low flow periods
- Seek dilution credit for key parameters
- Seek a water recycling credit
- Import flows from other plants or export ROC
- Treat ROC
- Beneficially reuse ROC in constructed wetlands

Hydrodynamic modeling and analysis of ROC discharge options is underway to evaluate ROC discharge at current publicly owned treatment works discharge locations and potential new outfall locations with more favorable dilution characteristics. This work is being performed in support of Valley Water's RO Concentrate Management Study by GHD. Another goal of this work is to apply a calibrated model to evaluate the ROC discharges into the lower South SF Bay in support of the regulatory process. The ROC management options that are being considered for the six potential AWPF sites are shown in Table 3-4. These options may be updated or expanded as conceptual alternatives are further defined.

Table 3-4. Short-listed ROC Management Options to be Further Considered (as of 2017)

AWPF Site	Options for Further Consideration		
Expanding SVAWPC	Effluent blending	Treatment cells	New shallow outfall
Sunnyvale	Treatment cells	Effluent blending	New shallow outfall with regional treatment
Palo Alto	Treatment cells	Effluent blending	New shallow outfall with regional treatment
Ford Ponds Satellite Facility	Sewer discharge	A mechanical/solidification option	
SCRWA	Evaporation ponds	Deep well injection	Connection to existing Watsonville ocean outfall
Regional AWPF	Treatment cells	New shallow outfall with regional treatment	Blending with existing East Bay Dischargers Authority outfall

Source: (Valley Water 2017a).

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Currently, both bench and pilot testing are being conducted to evaluate the benefits of ROC treatment (Mitch et al. 2017; Valley Water 2017b). These efforts are evaluating both engineered wetlands and oxidative pre-treatment to quantify these processes' ability to control a wide range of chemicals present in the ROC. Results from these efforts will be used to predict the impacts of the full-scale treatment on both water quality and habitat restoration. Ongoing experiments are evaluating two pilot-scale engineered wetlands at the SVAWPC site. The treatment cells comprise 300 square meters of wetland with a shallow water depth (0.3 meters) that provide 1 to 4 days of residence time; cells are evaluated regarding control of nutrients, trace organics, inorganics, and CECs/disinfection by-products (DBP). Another factor being evaluated is the impact of pretreatment with an oxidative process (both ozone- and UV-based processes).

3.2 Countywide Opportunities

Treatment facilities and distribution systems in the County have limitations, as discussed in Section 1.5. Several projects are under consideration that will expand the capacity and reliability of these existing systems.

3.2.1 Improvements via Interties

Interties connecting existing and potential NPR, IPR, and DPR systems can improve regional reliability and efficiency. A limited number of interties are currently in place, such as the connection between SBWR and the SVAWPC. Construction of additional interties will be considered as part of the conceptual alternatives development. Table 3-5 presents potential new interties that could improve supply reliability and resilience.

Table 3-5. Potential Interties to Increase Supply Reliability

From	To	Type
PA RWQCP	Sunnyvale WPCP	NPR
PA RWQCP	Sunnyvale WPCP	IPR
PA RWQCP	Los Gatos Ponds	IPR
PA RWQCP	Bay Division Pipeline	DPR
Sunnyvale WPCP	SBWR	NPR
Sunnyvale WPCP	Los Gatos Ponds	IPR
Sunnyvale WPCP	SVAWPC	IPR
Sunnyvale WPCP	PA RWQCP	DPR
SVAWPC	Los Gatos Ponds	IPR
SVAWPC	South Bay Aqueduct	DPR
SJ/SC RWF	Sunnyvale WPCP	NPR
SJ/SC RWF	Sunnyvale WPCP	IPR
SJ/SC RWF	SVAWPC	IPR
SCRWA WWTP	Santa Clara Conduit (via Scalping Plant)	DPR

3.2.2 Projected CIP Projects

This section reviews upcoming major CIP projects in the County related to wastewater treatment or recycled water production.

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3.2.2.1 PA/MV

The City of Palo Alto's 2012 Long Range Facilities Plan for the Regional Water Quality Control Plant identifies \$315M to \$392M in recommended upgrades over the next 50 years (City of Palo Alto 2012). Projects to be started before 2025 represent \$165M to \$242M and include:

- Upgrading solids handling
- Remodeling the laboratory and environmental services and operations buildings
- Replacing the headworks facility and grit removal system
- Replacing recycled water filters, chlorine contact tanks, and piping
- Rehabilitating:
    - Electrical/power support facilities
    - Primary sedimentation tank structure
    - Secondary clarifier
    - Dual-filter media
    - Fixed-film reactors
    - Sludge thickeners
    - Aeration basins

Palo Alto has prepared its Environmental Impact Report (EIR) (State Clearinghouse No. 2011062037, April 2015) for the Palo Alto Recycled Water project that will involve installation of two new pump stations and approximately 11 miles of 6-inch- to 18-inch-diameter pipeline (City of Palo Alto 2015). The new facilities will supply up to 900 AFY of recycled water for NPR.

Mountain View's proposed Whisman School Park/Central Expressway Alignment consists of approximately 36,000 LF of new pipeline and will serve an average day demand of 1,131 AFY. Project implementation is expected to be completed in phases, though exact timing is unknown.

Palo Alto and Mountain View, together with Valley Water, completed an Advanced Water Purification System Feasibility Study and are currently working on the Northwest County Recycled Water Strategic Plan. Both projects are in early planning stages, so costs and implementation schedules remain undetermined:

- **Advanced Water Purification System Feasibility Study:** Identified options to locate, at buildout, a 2.25-mgd AWPF, 3.0-MG permeate storage tank, and 2.41-MG recycled water storage tank on the RWQCP property. The intent was for purified water produced by the RWQCP to be used for NPR, with the concentrate discharge sent to the main RWQCP outfall for discharge to the SF Bay after blending with treated wastewater. The feasibility study also identified a location on the RWQCP site for a larger facility (6+ mgd) that could be used as a regional PR facility.
- **Northwest County Recycled Water Strategic Plan:** Expected completion 2019. This document is intended to clarify the groundwater sub-basin characteristics in the northwest portion of the County and how it interfaces with other areas, evaluate the feasibility of indirect PR as a groundwater management strategy, and establish a baseline to model potential impacts to groundwater under future use scenarios. This plan also evaluates RWQCP service area water reuse demands and expansion opportunities for increased PR and NPR in the service area. The intent is that the results of this document will integrate into this Master Plan once work is completed.

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3.2.2.2 Sunnyvale

In July 2016, Sunnyvale finalized an EIR (State Clearinghouse No. 2015062037) for the WPCP Master Plan (City of Sunnyvale 2013a). Plant upgrades proposed as part of the WPCP Master Plan include:

- Constructing new primary treatment facilities (currently in progress)
- Rehabilitating existing facilities
- Transitioning to conventional activated sludge
- Constructing a new filter control building and chloramine disinfection facilities
- Improving solids handling, including:
  - Thickening/dewatering
  - New digester
  - Fats, oils, and grease facility
  - Biosolids post-processing
- Remodeling administration and maintenance buildings
- Tidal flood protection
- Power, automation, and heating upgrades

Primary treatment upgrades are expected to be completed by late 2020, and secondary and tertiary treatment improvements will be completed by 2030. Implementation of the entire WPCP Master Plan is expected to be completed in 2042, and total costs are approximately $456M.

Sunnyvale’s 2017 WPCP Recycled Water Annual Report does not list any upcoming distribution system improvements (City of Sunnyvale 2017). Following the completion of the Wolfe Road main, the focus for 2018 in terms of recycled water seems to be completing the continuous production upgrade at the WPCP and new customer signups. For completeness, full system expansion (as laid out in the 2013 Feasibility Study for Recycled Water Expansion Report) is described below.

The proposed pipeline extensions in the 2013 Feasibility Study for Recycled Water Expansion Report will meet a recycled water demand of 1.84 mgd (2,061 AFY). The study also recommends adding 5 MG of new recycled water storage at either the Wolfe-Evelyn or Central Avenue water plant sites (City of Sunnyvale 2013b). New pipeline and pumping, storage, and treatment improvements will be implemented in four phases, and total capital costs will be approximately $114M. The above recycled water demand and project cost totals include the Wolfe Road main (Phase 1 in the study). The remaining phases will deliver approximately 1.40 mgd (1,566 AFY) of recycled water and cost $83.1M.

3.2.2.3 SBWR

The following discussion summarizes CIP efforts in three areas: (1) the RWF, (2) the recycled distribution system, and (3) the SVAWPC/purified water system.

SJ/SC RWF. The 2013 Plant Master Plan estimates $1B in RWF improvements just to continue operating with existing equipment (SBWR 2013). Through 2040, the RWF expects improvements to cost $2B. The following improvement projects are scheduled to start by 2025:

- Headworks modifications
- Primary treatment upgrades
- Secondary treatment upgrades
- Filter upgrades

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- New UV disinfection facilities
- Sludge fine screening
- Digester improvements
- Thickening upgrades
- Solids dewatering
- Lagoons/drying upgrades
- Solids drying
- Heat and power generation upgrades
- Solar power and digester gas storage
- Plant electrical reliability upgrades
- Advanced process control and automation

Recycled Distribution System. Distribution system improvements are described in Valley Water's and SBWR's 2014 Strategic and Master Planning, which sets a target of increasing recycled water use to 25,000 AFY by 2025 and 35,000 AFY by 2035 (SBWR 2014). Meeting these goals requires pursuing multiple pathways, including both NPR and PR. The framework for expansion in the near term (2015–2020) included IPR (recharge at Ford Pond) and improving distribution system reliability, specifically:

- Increasing TPS capacity
- Conducting filtration and chlorination studies to improve production capacity
- Upgrading Pump Station 5 bypass
- Constructing Zone 1 storage
- Addressing condition-related deficiencies (Pump Station 5 variable-frequency drives; valves; heating, ventilation, and air conditioning systems)
- Updating automation and control strategies

The near-term reliability improvements are estimated to cost between $45M and $49M, while the Ford Pond IPR project was estimated to cost $64.4M. Beyond 2020, SBWR may expand the pipeline system and pursue additional IPR, including delivering purified water to both recharge ponds and injection wells as described in the Strategic and Master Planning Report. The estimated capital cost for expanding the recycled water distribution system, including pipelines, pump stations, and storage, is $243M. Long-term PR project costs will cost $522M. These PR numbers were further updated by the public-private partnership (P3) approach described below.

SVAWPC/Purified Water System. Valley Water developed the Draft Expedited Purified Water Program Plan (Program Plan) in February 2018 to build on and update the contents of the SBWR Strategic and Master Planning (SBWR 2014). The Program Plan assumed that all source water would originate from the SJ/SC RWF, and that the existing RWF outfall could accommodate ROC from an expanded SVAWPC. In addition, the Program Plan recommended an initial alternative of delivering at least 24,000 AFY of purified water to the Los Gatos Ponds by expanding the SVAWPC capacity by 24 mgd, and constructing a new 18-mile, 48-inch-diameter purified water pipeline between the SVAWPC and Los Gatos ponds through San José, Santa Clara, and Campbell.

This project is proposed to be implemented through a P3 approach, under which a private entity will finance, design, construct, and operate the project, and deliver purified water to Valley Water at the Los Gatos Ponds. Valley Water initiated a P3 process in 2016 and recently updated the process to qualify additional P3 teams. Multiple new agreements and studies will be required, as well as new permits. The total capital cost for this

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project is approximately $651M. The current schedule for next steps in the P3 process envisions putting the project into operation by 2025.

Neither the City of Santa Clara nor San José Municipal Water System are currently planning significant distribution system projects. While system expansion details for SJW and the City of Milpitas follow, related demands and costs are reflected in the aforementioned SBWR Strategic and Master Planning information (SBWR 2014).

SJW, which owns, operates, and maintains portions of the existing SBWR distribution system, plans to construct recycled water main extensions (Alignments D, E, Q, P, L, and K) through the year 2029. The new pipelines, combined with new customer signups on existing mains, are expected to increase recycled water demand by 5.72 mgd (6,405 AFY). Alignment D is complete, and Alignment E is tentatively planned to be constructed in 2021. Construction of the other alignments is contingent upon executing a wholesaler-retailer agreement amendment between SBWR and SJW, and California Public Utilities Commission approval.

In October 2016, the City of Milpitas adopted a California Environmental Quality Act (CEQA) document for its Recycled Water Pipeline Extension project. This project will result in the construction of five new recycled water projects totaling 50,560 LF of distribution pipeline, a 1.5-MG storage tank at Cardoza Park, four booster pump stations, and connection of up to 0.67 mgd (751 AFY) of demand. There is no known schedule to implement these projects. Total project costs are estimated to be $45M.

3.2.2.4 SCRWA

SCRWA and Valley Water released a South County Recycled Water Master Plan Update in 2016 that evaluates expansion alternatives and recommends a 20-year, $98M CIP to increase non-potable recycled water use by 9.2 mgd (10,305 AFY) and improve system reliability (SCRWA 2015). The CIP includes pipelines, storage tanks, pump stations, and WWTP upgrades. As mentioned in Section 1.5, SCRWA has already completed some of the recommended WWTP improvements, including installing a UV disinfection system and constructing a second clarifier. Remaining major CIP efforts include:

- Increasing capacity of Pump Station 93
- Installing a membrane treatment train to operate in parallel with oxidation ditches
- Upgrading the solids dewatering system
- Constructing a new recycled water storage tank

A portion (Phase 1B and 2A) of the recommended alignment is being constructed as part of Valley Water's South County Recycled Water Pipeline project. The new 14,500-LF pipeline will expand service to western Gilroy while providing approximately 2.77 mgd (3,100 AFY) of recycled water.

3.3 Considerations

Two major factors that must be considered when expanding NPR and developing PR are public perception and supply reliability.

3.3.1 Public Engagement and Perception

Valley Water has an active and engaged public outreach program to help build public acceptance of recycled water. This program includes multiple community surveys, tours of SVAWPC, creation of a new website (www.purewater4u.org), creation of marketing collateral material in multiple languages and formats, and a public listing of recycled water supporters. Valley Water's marketing efforts have been recognized with awards at both the state and local level. More recently, Valley Water convened the IAP to review recommended recycled water and purified water alternatives, and to help guide its public outreach efforts.

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Most water retailers have websites explaining recycled water production, delivery, and safety. Typically, customers who are already connected to recycled water will have undergone Site Supervisor Training to understand how to use recycled water in accordance with all guidelines. Additionally, they will be required to conform to all reporting and monitoring requirements promulgated by the permit in effect for their retailer. Each retailer also has various contacts for general questions, document submission, and emergency response. Additionally, each municipality has ordinances in their municipal code requiring the use of recycled water where available. Some municipalities also have ordinances requiring buildings within a specified area to be dual-plumbed for recycled water use for toilet and urinal flushing.

Unique elements of the public engagement and public perception process for each retailer are summarized below.

3.3.1.1 PA/MV

City of Mountain View ordinances require the use of recycled water for irrigation systems within the North Bayshore Area. All new developments must be designed to use recycled water for landscape irrigation. Mountain View has posted “Customer Guidelines for Recycled Water Use” to outline the process for establishing and maintaining a recycled water service connection.

As part of its Recycled Water Feasibility Study, Mountain View surveyed customer interest in using recycled water. Most customers who responded expressed interest in using recycled water for NPR purposes on their property, if it were available. In general, customer responses also supported the idea of using recycled water at their property.

In 20.15, Palo Alto completed the public review process and adopted the final EIR for the City of Palo Alto Recycled Water project. In 2019, completed its Northwest County Recycled Water Strategic Plan (NW County Plan) to more fully explore Palo Alto’s reuse options. The NW County Plan includes a public outreach task to recommend next steps for public engagement. Should the City of Palo Alto proceed with any reuse expansion projects, it would need to increase public engagement with potential customers and the community.

3.3.1.2 Sunnyvale

Sunnyvale developed a marketing plan for recycled water as part of the Feasibility Study for Recycled Water Expansion Report (City of Sunnyvale 2013b). This plan was intended to inform stakeholders about recycled water and obtain potential customers’ commitment to use recycled water. Sunnyvale also has multiple outreach avenues, including Sustainable Sunnyvale, focused websites relating to water supply and distribution, recycled water, and its ESD. Most of Sunnyvale’s customers have been using recycled water since the early 2000s. Current Sunnyvale efforts focus more on new construction, system modifications, changes in ownership, and answering general questions. Sunnyvale also has constructed a demonstration garden at Baylands Park to illustrate the impact of recycled water on typical landscaping.

Customer coordination related to the new Wolfe Road recycled water pipeline is the responsibility of Valley Water as the wholesaler and Cal Water as the retailer.

3.3.1.3 SBWR

With more than 20 years of experience operating recycled water systems, SBWR and its retailers have made recycled water use and knowledge more ubiquitous and familiar to customers within their service area. SBWR has a relatively robust public outreach program, as it delivers recycled water to more than 850 customers in its service area. The focus of SBWR’s outreach is on maintaining compliance with rules and regulations, collecting annual site inspection reports, providing Site Supervisor Training, coordinating review of new developments, and working with retailers to coordinate customer connections—particularly new developments.

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SBWR performs Site Supervisor Training workshops several times a year to focus on the importance of recycled water, the role of the site supervisor, present guidelines for recycled water use, and provide guidance on managing recycled water use on its property. Through 2017, more than 1,700 attendees have become registered as site supervisors.

The City of San José also adopted a "Green Vision," of which Goal 6 is to recycle or beneficially reuse 100 percent of its wastewater. Put into performance metrics, the City's goal is to use approximately 40 mgd of effluent by 2022. A key aspect of achieving this goal rests in the City's partnership with Valley Water to expand the SVAWPC.

3.3.1.4 SCRWA

A customer survey completed as part of the 2015 South County Recycled Water Master Plan Update surveyed 25 customers with questions intended to gauge their interest and feasibility of using recycled water (SCRWA 2015). Of the customers surveyed, all but two expressed interest in using recycled water. Future customers are expected to be generally accepting of using recycled water for non-potable purposes in Gilroy.

Currently, recycled water is provided to eight customers outside of the plant. These customers include various City of Gilroy facilities, a local farm, power plant, the Eagle Ridge Golf Course, and the McCarthy Business Park. Additional private and public customers are expected to use recycled water in the future when new pipelines are constructed. As the use of recycled water diversifies to more private uses, additional customer coordination and outreach will be required on an ongoing basis.

3.3.2 Source Water Reliability

The Bay Area Integrated Regional Water Management Plan identifies system components that may be vulnerable to climate change (Kennedy/Jenks 2013). Many of these vulnerabilities apply to County recycled water treatment and distribution facilities. For example, because a warmer climate means higher evaporation losses, water demand may increase; more variable and extreme precipitation will also highlight reliability deficiencies; and the WPCP and RWF require additional flood control structures to protect against sea level rise and tidal flooding.

An example of the reduction in source water reliability is illustrated in Figure 3-5 in Section 3.1.1, as ADWF projections from the PA/MV RWQCP 2012 Long Range Facilities Plan were much higher than 2015 – 2017 actual flows. Declining plant influent flows resulting from drought, climate change, and increased water use efficiency may impact the potential water available for reuse. The evaluation in Section 3.1 has incorporated adjustments to account for declining flows, though future plant influent trends may vary.

Section 4: Gap Analysis

Based on the information collected and reviewed, important considerations for potential alternatives have been identified and are discussed in this section. Table 4-1 presents a summary of recommendations from this gap analysis.

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Table 4-1. PR Gap Analysis Recommendations

Consideration	Recommendation	
	GWR	DPR
Treatment	• Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Additional testing will be necessary if Valley Water decides to pursue non-RO based groundwater spreading options	• Additional testing of ozone/BAF to improve dosing control and assess benefits for downstream processes and ROC management • Additional testing to increase RO credits • Testing to evaluate UV/AOP (underway) • Demonstration testing of DPR treatment train to gain experience with integration of high-frequency data collection
Source water quality	• Characterize potential source waters for key constituents (e.g., NDMA)	• Consider quality of feedwater needed for DPR (e.g., nitrified/denitrified, tertiary filtered) • Consider pathogen monitoring study at WWTP to obtain removal credits
Regulations	• No regulatory gaps: GWR regulations finalized in 2014	• DPR regulations not anticipated until 2023 • Consider potential additional requirements, e.g., treatment, monitoring, operations
Source control	• Begin coordination with wastewater provider to broaden source control program	
Groundwater characterization	• Characterize groundwater basin retention times through tracer studies • Characterize availability of diluent water for tertiary spreading • Continue characterizing water quality of existing basins	• N/A
Environmental discharge	• Evaluate compliance with Salt and Nutrient Management Plans and antidegradation regulations • Likely to be more challenging with GWR via tertiary spreading	• N/A
Source water availability	• Secure agreements with wastewater partners	
ROC management	• Continue evaluation of RO concentration management strategies • Coordinate with wastewater agency that will receive ROC	
Demand (water supply needs)	• Valley Water plans to complete the WSMP in coordination with this Master Plan.	
Utilization rate	• Valley Water plans to complete the WSMP in coordination with this Master Plan.	

4.1 Data Supporting Potable Reuse Regulatory Approval

Valley Water's Expedited Purified Water Program has considered a range of PR options, including both GWR and the raw water augmentation form of DPR to meet its goal of producing at least 24,000 AFY for potable use. Valley Water evaluated multiple AWPF locations, groundwater spreading and injection options, and surface water augmentation, and selected five alternatives for further consideration:

- **Alternative 1:** Expanded SVAWPC with groundwater spreading at Los Gatos Ponds
- **Alternative 2:** Expanded SVAWPC and injection wells near Los Gatos Ponds
- **Alternative 3:** Expanded SVAWPC and raw water augmentation into South Bay Aqueduct or Central Pipeline
- **Alternative 4:** Ford AWPF with groundwater spreading at Ford Ponds

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- **Alternative 5:** Ford AWPF with surface water augmentation at Calero Reservoir

In this analysis, Valley Water made three key assumptions about the source water, treatment, and ROC management:

- Expanded SVAWPC receives source water from SJ/SC RWF: the evaluation assumed that diverting effluent to SVAWPC from the existing outfall would not negatively impact the SF Bay environment or salt marsh
- FAT treatment used for all PR options: FAT treatment was assumed for all IPR scenarios—including groundwater spreading options—to protect the quality of the groundwater and for consistency with the approved Salt and Nutrient Management Plan and PR outreach conducted to date
- Existing SJ/SC RWF outfall can accommodate expanded ROC flows: this assumption was based on preliminary results from an ROC management study (GHD, 2017).

After conducting this analysis, Valley Water selected Alternative 1: Use 24 mgd from an expanded SVAWPC for groundwater spreading at Los Gatos Ponds. This effort provided a great deal of clarity on the feasibility and cost of a future PR option. Many assumptions were needed to complete this analysis; those assumptions require further refinement and are included in the gap analysis.

The Master Plan will incorporate these and other PR and NPR alternatives to meet Valley Water's goals. As a result, some of the assumptions of the Expedited Purified Water Program may be revisited.

The following gap analysis considers a wider scope of source waters, treatment trains, and PR options.

4.1.1 Groundwater Recharge

As described in Section 2, Valley Water has undertaken multiple efforts to demonstrate the effectiveness of the SVAWPC in complying with the regulations for GWR. This section describes recommendations for future efforts that will aid in designing and permitting a future groundwater injection or groundwater spreading project.

4.1.1.1 Treatment Considerations for Groundwater Injection

This sub-section summarizes project capacity, RO, UV/AOP, and AWPF source water.

Project Capacity. The IAP Panel Report from the 2017 meeting asked Valley Water to provide better clarity on the capacity of the PR project at startup, as well as specific information on scheduling and phasing the projects from startup through full buildout (Crook et al. 2017). Since that meeting, additional clarity has been obtained through the Expedited Purified Water Program. While a preferred pathway to 24,000 AFY has been identified, one outstanding question is how this project could be expanded up to a total of 45,000 AFY of purified water, should it be needed to meet future water supplies

RO. One of the key items to develop through the permitting process is the degree of pathogen removal credit (i.e., log removal values [LRVs]) assigned to each unit process. One process that has been potentially under-credited is RO; this stems largely from the lack of sensitivity of the surrogates used to verify log removal performance—electroconductivity and TOC. Using novel RO surrogates has been an important recent research theme in the industry, with multiple potential alternatives providing LRV credit beyond those typically assigned (e.g., TRASAR™ [a proprietary fluorescent dye produced by NALCO], strontium, other inorganic ions). For example, the City of San Diego is seeking to receive up to 3-log credit for RO using strontium as an alternative RO performance surrogate. Valley Water is pursuing plans to also test fluorescent dye-based surrogates to expand RO credit from approximately 1.5-log to 3-log or more.

UV/AOP. Initial UV/AOP pilot testing at SVAWPC demonstrated the ability of UV/H_2O_2 to meet the GWR requirements for AOP processes (Valley Water 2016). The testing also revealed that UV/chlorine could not

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meet the same requirements under the range of conditions tested. The UV/chlorine findings depart from those undertaken for Terminal Island, San Diego, and Padre Dam, suggesting that additional UV/chlorine testing may be warranted. To that end, Valley Water is conducting additional UV/AOP pilot testing to evaluate both UV/chlorine and UV/H_2O_2 (Sangines 2017). This study will evaluate a range of scenarios to assist in the selection and design criteria for a future AOP process (UV dose, oxidant selection and concentration, chemical reduction performance), and complement previous UV/AOP pilot testing.

AWPF Source Water. One key item for the Master Plan is to identify the source water that will feed the future AWPF. If SVAWPC continues to receive effluent from SJ/SC RWF, it will be important to identify what degree of treatment is provided prior to the AWPC. There are advantages to using tertiary disinfected effluents as the AWPF feedwater. Recently, the City of San José has evaluated a sequential chlorination process that combines a short *free* chlorine CT (product of chlorine residual [C] and contact time [T]) followed by a longer *chloramine* CT. This process offers many advantages, including: (a) a high degree of virus inactivation (greater than 5-log); (b) effective coliform control; and (c) minimization of trihalomethane, haloacetic acid, and NDMA formation. One known issue with the FAT train is that it alone does not provide sufficient credits to meet the 12-log virus reduction requirement of the GWR regulations. Using a sequentially chlorinated feedwater will provide an additional 5-log virus credit while helping to control DBP formation. Further, filtered effluents provide an added layer of protection and water quality stability for the downstream AWPF. Filtration offers several benefits, including:

- Providing an added barrier against particulate matter (e.g., secondary clarifier upsets)
- Preventing the passage of organisms that can impact the performance of membrane processes (e.g., the blinding of pre-screens on MF processes)
- Enhancing membrane performance by providing additional turbidity and solids removal

One outstanding water quality issue identified in the 2016 Test Plan report was a high degree of variability in NDMA levels (Valley Water 2016). Regardless of the source water selected, it will be important to fully characterize the NDMA present in the water to ensure that the UV/AOP system is designed to reduce the levels below the notification level.

4.1.1.2 Treatment Considerations for Groundwater Spreading

Ozone/BAF-treated water was evaluated through pilot testing at the SVAWPC. Several issues were identified through ozone/BAF pilot testing that must be resolved before considering this option. The treated effluents could not meet the requirements for a few water quality parameters including TOC, NDMA, and nitrate. In spreading projects, both the aboveground treatment and SAT can be used to comply with the treatment and water quality criteria. One way to gain a better understanding of SAT's ability to further treat the ozone/BAF-treated effluents is through soil column testing. We recommend performing a soil column study to understand the feasibility of a spreading project and identify what additional treatment or other steps are required to meet the criteria.

Additional ozone testing would also be useful to gain operational experience with the dosing control system. During pilot testing, various factors impacted the ability of the ozone dosing system to provide a consistent ozone concentration (e.g., the presence of chlorine residual in the ozone feedwater). Gaining additional experience with O&M of the ozone/BAF system will also be useful for the design of the future full-scale system.

Ozone has been used in recycled water settings to provide disinfection in compliance with the Title 22 recycled water regulations. To date, a handful of recycled water facilities have received approval from the California State Board's DDW for ozone disinfection using the CT framework that is common in drinking and recycled water settings. One alternative crediting scheme that was evaluated during pilot testing was using the ozone-to-TOC ratio instead of ozone CT (Valley Water 2016). While this is an attractive option to reduce

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the operational costs of the ozone process, DDW has not yet permitted a facility using this crediting framework. The feasibility of this approach remains uncertain, but it is likely that securing this approval will require extensive dialogue with DDW and potentially additional testing.

In addition to resolving these technical issues, there are other considerations associated with the use of a non-RO based treatment train for groundwater spreading. These include compliance with the Salt and Nutrient Management Plan and Antidegradation requirements, as well as public outreach efforts. Valley Water will need to further study these issues if they decide to pursue a non-RO based treatment train for spreading.

4.1.1.3 Source Control

As described in the Regulatory Compliance Strategy Technical Memorandum (TM), the requirements for source control are significantly more stringent in PR settings. This stems from the fact that source control expands beyond environmental protection to also include public health protection. Significant coordination with the wastewater provider would likely be required as the scope of their source control program broadens.

4.1.1.4 Groundwater Characterization

One of the key elements for permitting GWR projects is demonstrating sufficient response retention times in the aquifer (see the Regulatory Compliance Strategy TM). Valley Water has updated its groundwater model to characterize the capacity and retention times of the proposed basins (see Section 2.4.1). Per regulations, numerical modeling must be followed by either an added or intrinsic tracer (see the Regulatory Compliance Strategy TM), as these latter options provide greater accuracy in estimating aquifer retention time.

Beyond characterizing retention time, spreading projects using tertiary-treated water will also require significant levels of diluent water. The recent groundwater modeling results looked at the percent contribution of purified water in potable supply wells in several locations. At the potable supply wells receiving percolated pond water from the Los Gatos Ponds, the Recycled Water Contribution (RWC, see the Regulatory Compliance Strategy TM) is 38 percent (Todd Groundwater, 2017b). For this RWC to be sufficient for regulatory compliance for tertiary spreading, the TOC would have to be 1.3 mg/L. Pilot testing demonstrated that ozone/BAF lowered the TOC to between 2 and 7 mg/L. Given this constraint, the capacity of a tertiary spreading project is likely to be limited by the diluent water available. Further characterizing diluent water availability will be critical to identify the capacity and feasibility of a GWR project via spreading of tertiary effluents.

Valley Water has historically carried out a rigorous water quality monitoring plan to characterize and protect the quality of its groundwater basins. DDW has additional monitoring requirements for GWR projects to further characterize the receiving water quality and to provide an early warning of any potential degradation in groundwater quality. Valley Water is currently undertaking this monitoring program in accordance with DDW requirements (Todd Groundwater, 2017c). The results of this monitoring will be useful in demonstrating compliance with DDW and environmental regulations, including the salt and nutrient management plans and anti-degradation requirements.

4.1.1.5 Source Water Availability

To date, Valley Water has developed MOUs with multiple regional partners. Securing an MOU with the City of San José is an next important step. The Master Plan will provide information to help understand the availability of resources to pursue both recycled (non-potable) and purified (potable) water options. An MOU with San Jose is important not only for source water availability, but also to coordinate other elements of the program, including source control and ROC management. Potential terms for the purified water MOU were presented at the 2017 IAP meeting (Table 4-2).

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Table 4-2. Potential Terms for Purified Water MOU with CSJ

Issues	Valley Water Proposal
Land	25+ acres
Treated wastewater	~30 mgd initially
Wastewater quality	Secondary or tertiary
ROC	~6 mgd

Source: (Ashktorab 2017).

4.1.1.6 ROC Management

Valley Water continues to evaluate options for ROC management. In addition to the technical questions identified in Section 3.1.3, this topic will also require coordination with the wastewater agency that will receive the concentrate. This is key because the ROC discharges must comply with the wastewater agency's NPDES permit. Other details to negotiate include how Valley Water will share liability with the wastewater agency for compliance, how it will coordinate compliance testing (e.g., toxicity testing), and how it interacts with the Regional Water Quality Control Board (RWQCB) (Daniel 2017). Assuming that the future project will include partnering with the City of San José, the IAP recommended that Valley Water and the City consult with the RWQCB executive officer to jointly work out an approach for ROC management (Crook et al. 2017).

4.1.1.7 Demand (Water Supply Needs)

Valley Water plans to complete the WSMP in coordination with this Master Plan. The WSMP will describe new water supply investments Valley Water is planning to make (such as storage), the anticipated schedule, and the associated costs and benefits. The Master Plan identifies the water available for PR and alternatives for future development, contingency planning, and regional efficiencies, such as interties.

4.1.1.8 Utilization Rate

Component economics are also a function of utilization rate, which is the estimated long-term average annual yield divided by the maximum annual yield. The utilization rate is impacted by hydrologic conditions, groundwater levels, water demand, and water supply policy or prioritization decisions (RMC, 2018).

4.1.2 Direct Potable Reuse

Valley Water is also interested in exploring options to implement DPR. Motivations for this pursuit include lower infrastructure requirements (e.g., pipelines, injection wells), simpler operations, and its ability to capitalize on existing facilities. This sub-section identifies outstanding issues that require further clarification or study to pursue DPR.

4.1.2.1 Regulatory Considerations for DPR

The most significant hurdle to the pursuit of a DPR project is the lack of regulatory certainty around how both forms of DPR (raw water augmentation and treated water augmentation) will be permitted. Regulations for both forms of DPR are being developed and are anticipated by December 2023. The Regulatory Compliance Strategy TM describes anticipated elements of future DPR regulations based on recent publications from DDW and the California DPR Expert Panel. One significant unknown is the level of treatment required for DPR projects, including future pathogen log removal requirements. To date, Valley Water has tested a pilot ozone/BAF system as potential pretreatment for a downstream FAT train. This train has been evaluated in previous testing and shown to provide a reliable degree of performance for DPR (Pecson et al. 2017). This train was also identified by the California DPR Expert Panel as a potential future option for DPR (State Water

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Resources Control Board 2016). Greater clarity on the minimum requirements for DPR—and the suitability of the ozone/BAF/MF/RO/UV-AOP treatment train—should be available by 2023.

4.1.2.2 Treatment Considerations for DPR

This sub-section summarizes several treatment considerations, including ozone/BAF, RO and UV/AOP, data integration and control, and AWPF source water.

Ozone/BAF. Valley Water has gained valuable experience with ozone/BAF process through previous piloting work. Additional ozone/BAF testing may benefit the permitting of a future DPR system in the following ways.

- Evaluating ozone control systems: One finding from the ozone/BAF pilot testing was that ozone dosing control was difficult to achieve due to several potential factors. Additional testing will allow Valley Water to evaluate different monitoring and control systems, gain additional proficiency with the process, and use that information to help inform a potential future full-scale facility.
- Assessing the impact on downstream processes: Incorporating ozone/BAF into a FAT train provides numerous benefits, including enhanced performance of the downstream MF/ultrafiltration (UF) and RO processes. For example, the City of San Diego has been able to design its future full-scale UF systems with significantly higher flux rates as a result of ozone/BAF pretreatment. The City of San Diego's ability to make this decision stemmed from its extensive demonstration testing, which included an assessment of membrane performance. Additional benefits of ozone/BAF include longer intervals between membrane cleanings and cleans-in-place, decreased backwash frequency, and reduced dependence on chloramines for performance.
- Evaluating benefits for ROC: Ongoing work on ROC management is evaluating several options including ROC treatment (Mitch et al. 2017). The ROC ozone treatment option is challenging due to the difficulty of introducing sufficient ozone into the high-TOC ROC stream. Applying ozone to the AWPF feedwater (instead of the ROC) would use similar amounts of ozone overall, assuming that the ozone is applied in proportion to the TOC in the water being treated. At this location, however, the ozone will provide numerous benefits in terms of disinfection, chemical control, and membrane performance. Further, reducing the level of toxic contaminants in the RO feed will also reduce the concentrations in the ROC, and may reduce the need for downstream ROC treatment.

RO and UV/AOP. The same considerations discussed in Section 4.1.1 related to the RO and UV/AOP systems also apply for DPR.

Data Integration and Control. One of the challenges of PR systems that do not use an environmental buffer is the loss of time to respond to issues that might impact the quality of the water. Consequently, DPR systems will likely be forced to meet more stringent requirements for process monitoring and control than GWR systems. One major challenge will be integrating the numerous monitors that measure process performance and developing control systems that can use this information to rapidly make decisions. This knowledge gap has been identified by the Water Research Foundation as a potential high-priority topic for DPR. Demonstration DPR treatment train testing will allow Valley Water to gain experience with integrating high-frequency data and developing rapid and reliable control systems, while demonstrating to DDW its ability to operate a complex and highly engineered treatment system.

AWPF Source Water. The level of treatment that will be required for source waters to DPR facilities remains uncertain, though the DPR Expert Panel recommended that high-quality source waters will further ensure the reliability of the downstream AWPF. The DPR Expert Panel recommended that DPR facilities receive source waters that have undergone both biological nutrient removal (e.g., nitrification/denitrification) and tertiary filtration (State Water Resources Control Board 2016). This recommendation is in line with previous DPR guidance (Tchobanoglous et al. 2015).

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Another priority DPR research topic is characterizing pathogen concentrations in raw wastewater and their reduction through WWTPs. To date, numerous IPR projects have sought and gained pathogen log removal credits through WWTPs. As the industry gains a better understanding of the factors influencing pathogen removal through WWTPs, site-specific studies are anticipated to be required for pathogen crediting (instead of relying on literature values). Given the high degree of biological treatment and filtration provided at the SJ/SC RWF, it is likely that pathogen LRVs can be demonstrated through tertiary treatment. These credits are essentially free because they are associated with an existing process. These would apply toward the overall pathogen reduction requirements and offset the need for additional treatment barriers.

4.1.2.3 Source Control

The same source control considerations discussed in Section 4.1.1 will also apply in DPR settings. Source control is one of the six priority research topics being pursued by California to inform future DPR regulations. Accordingly, new recommendations for DPR source control should be forthcoming; DPR source control requirements are anticipated to be more robust than IPR source control programs.

4.1.2.4 Source Water Availability

The same source water availability considerations discussed in Section 4.1.1 will also apply in DPR settings.

4.1.2.5 ROC Management

The same ROC management considerations discussed in Section 4.1.1 will also apply in DPR settings.

4.2 Project Requirements

Project requirements will vary widely depending on the project alternative(s) selected. Key considerations will include:

- Updates to NPDES permits, such as petitions to change in place of use
- Modifications to recycled water permits, tentative orders, etc.
- Assessment of pipeline alignments, right-of-way requirements, easements and construction impacts
- Determination of environmental report requirements, including potential flows for environmental benefit
- Thorough evaluation of the system receiving PR water, such as the groundwater basin or distribution system
- Comprehensive identification of facilities needed, including land acquisition, capital, and O&M costs

4.3 Resource Gaps

Recycled water facilities contain treatment processes that are familiar to water and wastewater operators. PR facilities incorporate advanced treatment processes with specific actions or monitoring (e.g., critical control points) that may require additional training and certification. The California Water Environment Association, in collaboration with California-Nevada Section of the American Water Works Association, is developing a training and certification program for advanced water treatment operators. While the details of the program are still in development, this type of training and certification will be applicable to potential PR alternatives.

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Appendix E-2: Recycle Hill Geotechnical Preliminary Study

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Brown AND Caldwell

75 E Santa Clara Street, Suite 375
San José, CA 95113

408.703.2535

Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC internal)

Contract no.: A4120A

Appendix E-2

Subject: Geotechnical Preliminary Study: Recycle Hill

Date: July 13, 2018; reissued June 30, 2020

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, Brown and Caldwell Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

Prepared by: Dustin Agnew, P.E., Geotechnical Consultants, Inc.
California License: C79292

Bill Leever, P.G., P.H.G., Brown and Caldwell
California Licenses: PG 6815, CHG 827

Reviewed by: James Thurber, P.G., Geotechnical Consultants, Inc.
California License: PG 4197

Martin Steinpress, P.G., P.H.G., Brown and Caldwell
California Licenses: PG 5090, CHG 29

Limitations:

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Table of Contents

Section 1: Introduction 1
1.1 Background and Scope 2
  1.1.1 Geotechnical and Geologic Data Review 2
  1.1.2 Environmental Data Review 3
  1.1.3 Regional Geologic Setting 3
  1.1.4 Regional Seismic Setting 5
  1.1.5 Site Location and Past Use 8
  1.1.6 Site Conditions 8
Section 2: Site Conditions 10
2.1 Geotechnical Conditions 10
  2.1.1 Strong Ground Shaking 10
  2.1.2 Fault Rupture 10
  2.1.3 Groundwater Depth 11
  2.1.4 Liquefaction 11
  2.1.5 Lateral Spread 12
  2.1.6 Dynamic Settlement (Densification) 12
  2.1.7 Consolidation Settlement 12
  2.1.8 Landslides/Slope Instability 12
  2.1.9 Tsunami 12
  2.1.10 Sea Level Rise 12
  2.1.11 Corrosion 13
2.2 Geoenvironmental Conditions 13
  2.2.1 Onsite Groundwater Conditions 17
  2.2.2 Onsite Surface Water Conditions 22
  2.2.3 Onsite Leachate Conditions 22
  2.2.4 Offsite Groundwater Concerns 23
Section 3: Site Inspection Observations 24
Section 4: Data Gaps 24
4.1 Geotechnical 24
4.2 Geoenvironmental 24
Section 5: Recommendations for Further Study 24
5.1 Geotechnical 24
5.2 Geoenvironmental 25
Section 6: Closure 26
References 27
Attachment A: Geotechnical Exploration Plan .... A

List of Figures

Figure 1-1. Site location map 1
Figure 1-2. Regional geologic map 4
Figure 1-3. Regional fault map 6
Figure 1-4. Aquifer conceptual model 10
Figure 2-1. Sunnyvale Landfill monitoring points 15
Figure 2-2. March 2018 groundwater elevation contours 19
Figure 2-3. GeoTracker search of Sunnyvale Landfill 23

List of Tables

Table 1-1. Summary of Reviewed Geotechnical Borings 3
Table 1-2. Significant Active and Potentially Active Faults 7
Table 2-1. Summary of Groundwater Readings 11
Table 2-2. Groundwater Levels at Recycle Hill 17
Table 2-3. Groundwater Quality at Recycle Hill 21
Table 2-4. Leachate Quality at Recycle Hill 22
Table 5-1. Geoenvironmental Soil and Groundwater Analytical Recommendations 26

List of Abbreviations

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
µg	microgram(s)
af	artificial fill
BAAQMD	Bay Area Air Quality Management District
BCDC	San Francisco Bay Conservation and Development District
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CAP	Corrective Action Program
CCR	California Code of Regulations
CGS	California Geological Survey
COD	chemical oxygen demand
CPT	cone penetration test
EPA	U.S. Environmental Protection Agency
ft	foot/feet
GEP	Geotechnical Exploration Plan
GTM	Geotechnical Study Technical Memorandum
LGMP	Leachate and Groundwater Management Plan
LUST	leaking underground storage tank
MCL	maximum contaminant level
MHHW	mean higher high water
MSW	municipal solid waste
MTBE	methyl tert-butyl ether
M_w	maximum moment magnitude
NA	not applicable
NAVD88	North American Vertical Datum of 1988
ND	not detected
PCE	tetrachloroethene
PEL	permissible exposure limit
Obm	Bay Mud
Ohb	basin deposits
RWQCB	Regional Water Quality Control Board
SCI	Subsurface Consultants, Inc.
SCS	SCS Engineers
SMR	Self-Monitoring Report
TCE	trichloroethene
UCERF 2	Uniform California Earthquake Rupture Forecast, Version 2
Ulrick	Ulrick & Associates
USGS	United States Geological Survey
Valley Water	Santa Clara Valley Water District
VOC	volatile organic compound
Water Board	State Water Resources Control Board
WPCP	water pollution control plant
WGCEP	Working Group on California Earthquake Probabilities

Section 1: Introduction

This Geotechnical Preliminary Study Technical Memorandum (GTM) presents a discussion of geologic, geotechnical, and environmental conditions at a project site being considered for a recycled water treatment facility. The project site is generally known as Recycle Hill and is one of four closed areas within the City of Sunnyvale municipal solid waste (MSW) landfill, located directly south of the Sunnyvale Water Pollution Control Plant (WPCP). The City of Sunnyvale is the owner and operator of record for the Sunnyvale Landfill and currently monitors the landfill under the Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012). The discussions, interpretations, and conclusions presented in this GTM are intended to support a feasibility assessment and the planning required to proceed with the siting, design, and construction of new facilities for a recycled water treatment plant near West Caribbean Drive and Borregas Avenue in Sunnyvale, California, as shown on Figure 1-1.

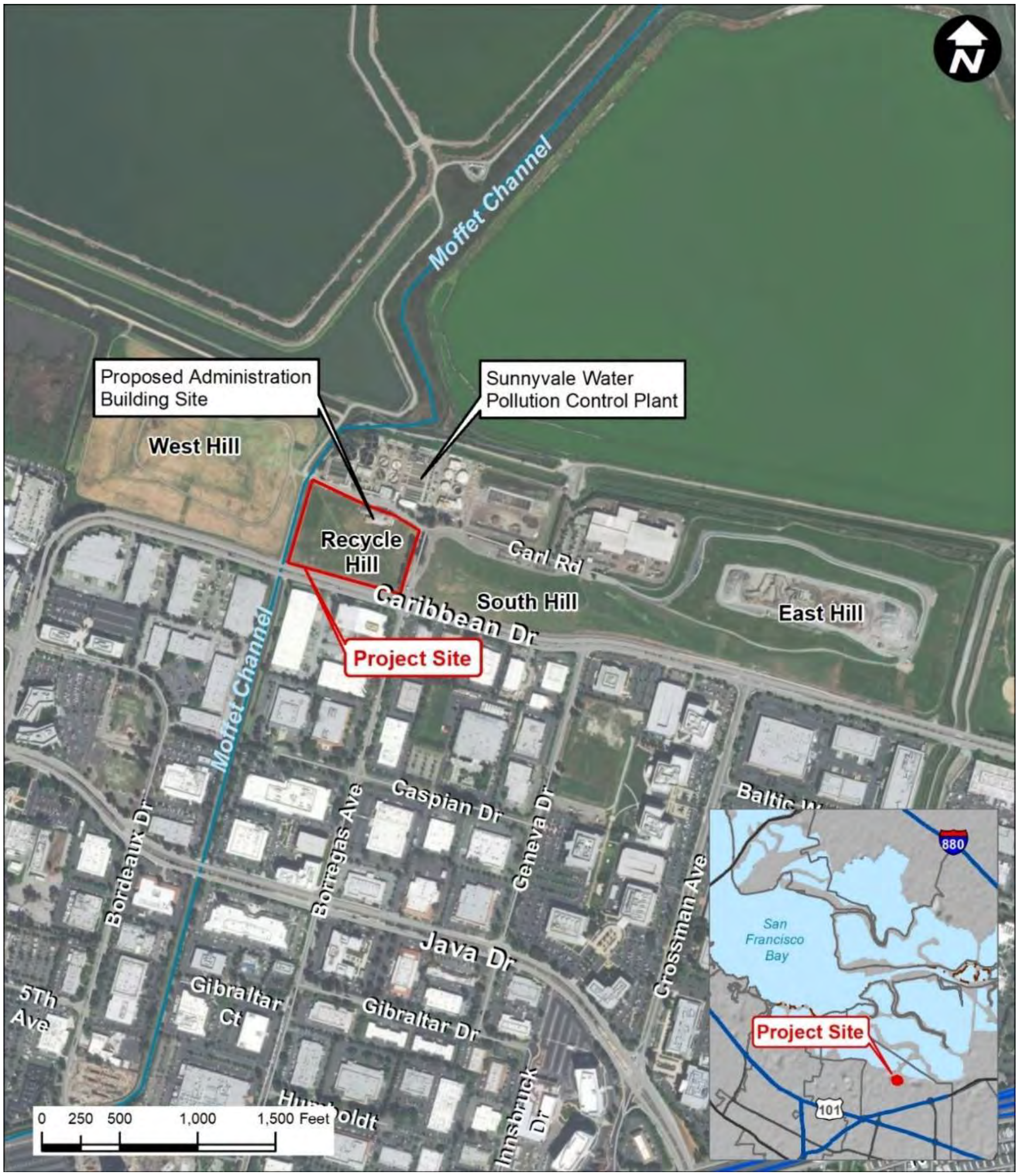


Figure 1-1. Site location map

1.1 Background and Scope

The purpose of this GTM is to review available geologic, geotechnical, and geoenvironmental information to support a feasibility assessment to use the project site for constructing a new recycled water treatment plant after the landfill waste is removed. This GTM is general in nature and is not intended for the analysis, design, and construction of new buildings and facilities at the proposed treatment plant site. Geotechnical interpretations for the project include:

- an overview of the regional geologic and seismic setting
- generalized discussion of the subsurface soil and groundwater conditions
- an assessment of geologic hazards
- assessment of geoenvironmental conditions related to soil and groundwater contamination below and adjacent to the closed landfill.

In May 2018, a geotechnical engineer completed a site reconnaissance around Recycle Hill and by walking on the mound slopes to note the overall slope condition and evidence of creep, slope failure, or erosion.

Geotechnical conditions are presented to discuss general considerations for the design and construction of possible foundation schemes. Geotechnical recommendations for final design should be based on a detailed geotechnical investigation, laboratory testing program, and geotechnical analysis that more specifically addresses preliminary layouts of treatment plant facilities.

Geoenvironmental conditions are presented to identify the known soil and groundwater conditions related to the release of hazardous materials into the environment and how those releases could impact the future development of Recycle Hill.

1.1.1 Geotechnical and Geologic Data Review

The team prepared and submitted a data request to the Santa Clara Valley Water District (Valley Water) and the City of Sunnyvale. The data requested and received are summarized in Attachment A.

Two sets of geotechnical borings drilled for earlier investigations at the proposed WPCP administration building site were reviewed for the preparation of this GTM. The boring logs were included in a work plan for a new geotechnical investigation for the proposed administration building (Geosyntec 2017) and in the geotechnical study for new improvements at the WPCP (Fugro 2016). These reports provided seven geotechnical borings as performed by Subsurface Consultants, Inc. (SCI 1992) and Fugro Consultants, Inc., (Fugro 2016) that are near the proposed recycled water treatment plant site. These seven borings and the proposed administration building site are located at the north edge of the proposed recycled water plant site (Figure 1-1). A summary of the borings is presented in Table 1-1.

Table 1-1. Summary of Reviewed Geotechnical Borings

Boring[a]	Date Drilled	Approximate Ground Surface Elevation (ft)	Approximate Depth to Bottom of Boring[b] (ft)	Approximate Depth to Groundwater[b] (ft)	Approximate Depth to Top of Observed Refuse (ft)[b]	Approximate Depth to Bottom of Observed Refuse[ab] (ft)
TB-6	July 1992	3.3[c]	31	12	2.5	11.5
TB-7	July 1992	3.3[c]	31	14	8.5	16.0
TB-8	July 1992	3.7[c]	31	12	0	16.5
TB-10	July 1992	3.8[c]	101	14	NA	NA
B-12	October 2014	107.0 +/-[d]	51.5	12.5	2.5	11.0
B-13	October 2014	107.0 +/-[d]	101.5	13.0	2.5	14.0
B-14	October 2014	106.0 +/-[d]	51.5	Not observed	2.5	6.5

a. *Borings TB-6 through TB-10 from SCI 1992; borings B-12 through B-14 from Fugro 2016.*
b. *Depths given as measured from existing ground surface at time of drilling.*
c. *The exact elevation datum used on reviewed SCI boring logs is unknown.*
d. *Datum noted on Fugro boring logs is assumed to be NAVD88 +100 feet, as is common practice at locations where NAVD88 is near 0 ft.*

1.1.2 Environmental Data Review

Existing geoenvironmental data, reports, and studies performed at or near Recycle Hill were reviewed and used in the preparation of this GTM. The data included groundwater level and quality data, landfill leachate and gas collection systems data, and soil boring data. Valley Water and the City of Sunnyvale provided several documents related to the site, including the primary documents used in the geoenvironmental investigation. These two documents are the City of Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012) and the Annual Self-Monitoring Report: Corrective Action Program, City of Sunnyvale Landfill (Ulrick 2018).

An Internet search for information related to Recycle Hill was conducted to determine offsite soil and groundwater conditions that could potentially have an impact on future site development. The State Water Resources Control Board’s (Water Board) GeoTracker website is a data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater. GeoTracker contains records for sites that require cleanup, such as leaking underground storage tank (LUST) sites, U.S. Department of Defense sites, and cleanup program sites. GeoTracker records for the subject site pertained to monitoring of groundwater, leachate, and surface water for the Sunnyvale landfill that provided groundwater level data and water quality data (Sunnyvale Landfill Self-Monitoring Reports, Corrective Action Program, 2005 through 2017). No other subsurface information, such as boring logs, was available in the GeoTracker data.

The specific GeoTracker site name for the Sunnyvale Landfill is “Sunnyvale Solid Waste Disp (L10003423381).” GeoTracker data from several of the sites were used in this study and are further discussed in Section 2.2.4.

1.1.3 Regional Geologic Setting

The project site at Recycle Hill is located at the north end of broad alluvial fans that slope gently to the north from highland areas surrounding the southern Santa Clara Valley. The Holocene-age alluvial deposits, formed on a broad flat plain at the margin of San Francisco Bay, are distinctly fine-grained sand, silt, and clay and referred to as alluvial fan (Qhaf) and basin deposits (Qhb) (Figure 1-2, Brabb et al. 2000). The site is underlain by silty clay fan deposits that merge northward (and locally overlie) with estuarine organic clay and silty clay generally referred to as Bay Mud (Qhbm). The alluvial fan basin deposits in the project area contain carbonate nodules or concretions and iron staining indicative of the mixing of fresh water and sea water at the bay margin interface (Brabb et al. 2000). Basin deposits are very fine silty clay deposits that reached the distal edge of the alluvial fan.

The project site is bounded on the west by artificial levees (alf) that border Moffett Channel, which drains northward between salt ponds to reach Guadalupe Slough. Recycle Hill is a 40-foot-high mound representing one of four cells of the closed City of Sunnyvale MSW landfill. Nearby geotechnical borings encountered 9 to 14 feet of artificial fill overlying lean clay, lean clay with sand, and sandy lean clay. The clay deposits represent the Holocene distal alluvial fan deposits (SCI 1992; Fugro 2016). Soft Bay Mud (Qhbm) was not encountered in these borings located on the north side of Recycle Hill or in borings located 500 feet north within WPCP (Fugro 2016).

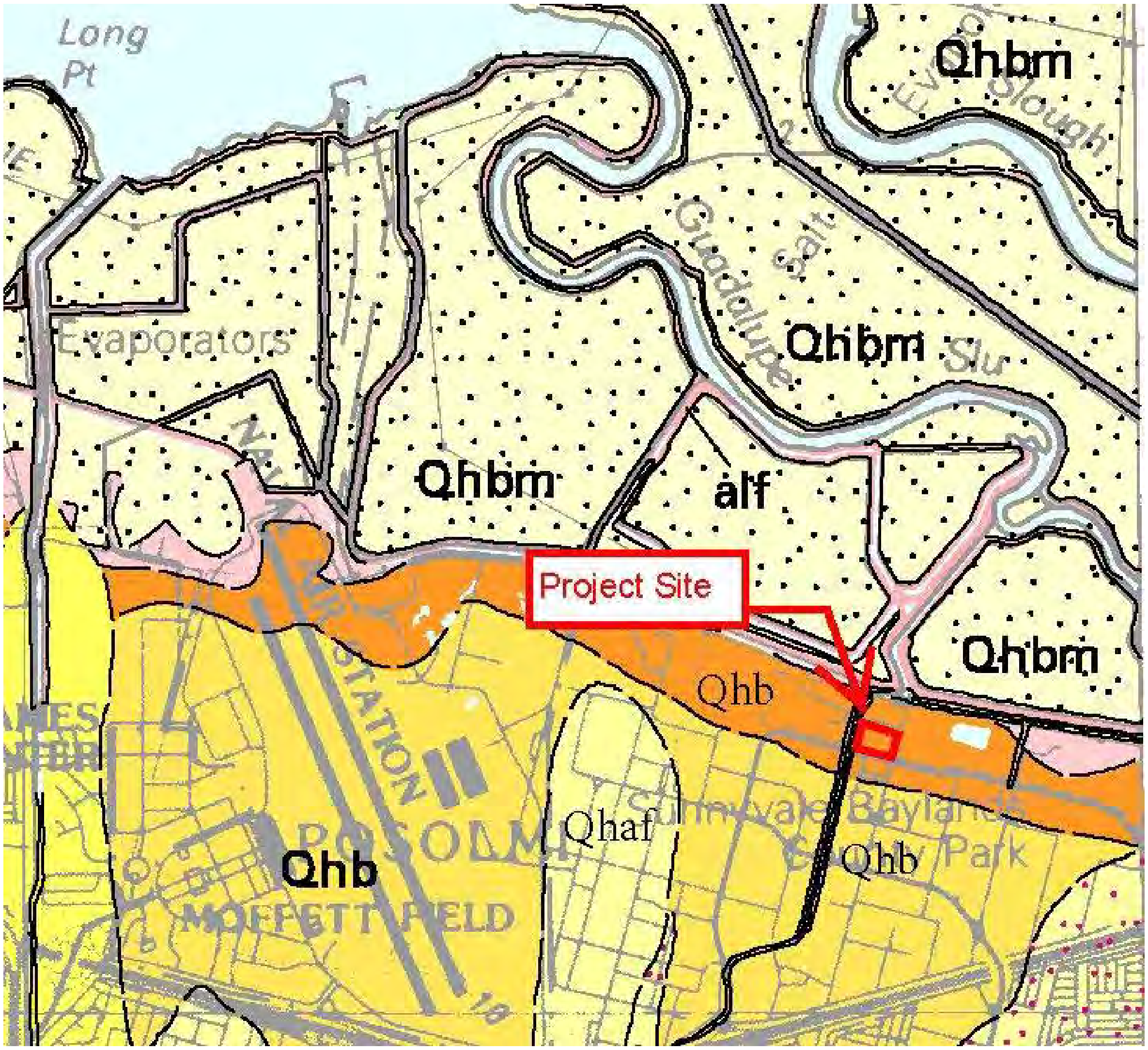


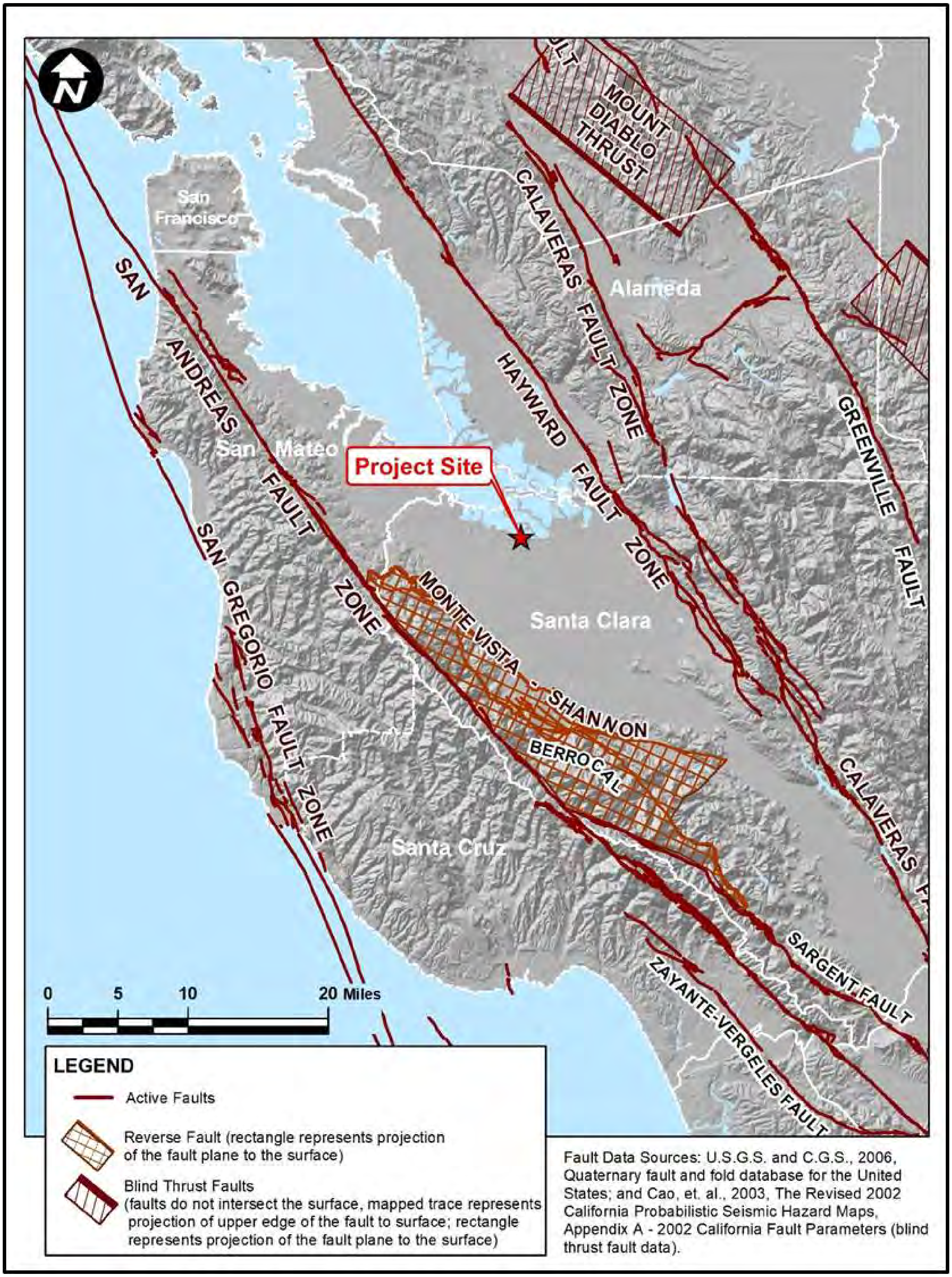
Figure 1-2. Regional geologic map

1.1.4 Regional Seismic Setting

Recycle Hill is in a seismically active region near the boundary between two major tectonic plates—the Pacific Plate to the southwest and the North American Plate to the northeast. The relative movement between the Pacific Plate and the North American Plate generally occurs across a 50-mile-wide zone extending from the San Gregorio Fault in the southwest to the Great Valley Thrust Belt in the northeast. Strain produced by the relative motions of these plates is relieved by right lateral strike slip faulting on the San Andreas Fault Zone and related faults (San Gregorio, Calaveras, and Hayward), and by vertical reverse slip displacement on the Great Valley and other thrust faults in the central California area.

Strong ground shaking at the project area could occur from an earthquake on any one of the active regional faults shown on Figure 1-3. The San Andreas Fault, the dominant tectonic feature of the San Francisco Peninsula, is the primary structure within the broad transform boundary that accommodates right lateral motion between the North American and Pacific tectonic plates. The United States Geological Survey (USGS) 2014 Working Group on California Earthquake Probabilities (2014 WGCEP) has concluded that there is a 72 percent probability of a strong earthquake (maximum moment magnitude [M_w] ≥ 6.7) occurring in the San Francisco Bay region over the next 30 years, starting in 2014 (2014 WGCEP 2015a). Additionally, the 2014 WGCEP (2014 WGCEP 2015b) has concluded that within the next 30 years (starting in 2014) the probability of a strong earthquake ($M_w \geq 6.7$) occurring on regional faults is:

- 33 percent for the North San Andreas Fault Zone
- 32 percent for the Hayward-Rodgers Creek Fault Zone
- 25 percent for the Calaveras Fault Zone



Fault Data Sources: U.S.G.S. and C.G.S., 2006, Quaternary fault and fold database for the United States; and Cao, et. al., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, Appendix A - 2002 California Fault Parameters (blind thrust fault data).

Figure 1-3. Regional fault map

Active faults in California have been divided into activity categories by the California Geological Survey (CGS) based on their predicted activity and ability to generate strong earthquakes:

- Type A faults, which generally have higher and more well-defined slip rates and well-defined recurrence intervals
- Type B faults, which generally have well-defined slip rates but poorly constrained recurrence intervals

Type A faults are commonly considered more active (generally with higher slip rates) and/or capable of generating larger earthquakes than Type B faults. USGS has divided the major active faults in the San Francisco Bay Area into segments based on work by the 2007 WGCEP (WGCEP 2008). Based on this segmentation, various fault rupture scenarios were developed that include earthquakes and rupture of segments of the individual faults in varying segment combinations, i.e., rupture of one segment by itself or rupture of two or more segments concurrently. These scenarios result in differing earthquake and fault parameters for each of the potential segment combinations.

Both Type A and Type B faults that are mapped in the region are summarized in Table 1-2. The nearest Type A faults to the project site are the Peninsula segment of the San Andreas Fault, passing about 10.5 miles to the southwest, and the Hayward Fault, located 7.2 miles to the east. The distance to significant active faults and fault segments from the approximate center point of the project area, CGS assigned fault type (A or B), estimated maximum magnitude earthquake, and 30-year probability of a M_w ≥6.7 earthquake on the fault or fault segments, are summarized in Table 1-2.

Table 1-2. Significant Active and Potentially Active Faults

Fault Name	Distance to Faulta (miles)	Estimated Earthquake Magnitudeb	30-Year Probability of Mw >6.7 Earthquakec (percent)
Active Type A Faults			
North San Andreas segments: Offshore, North Coast, Peninsula, Santa Cruz Mountain	10.5	7.9	33
North San Andreas Segments: Peninsula, Santa Cruz	10.5	7.5	
North San Andreas Segment: Peninsula	10.5	7.2	
North San Andreas Segment: North Coast	16.7	7.1	
Hayward–Rodgers Creek: Rodgers Creek, North and South sections	7.2	7.3	32
Hayward–Rodgers Creek: North and South sections	8.7	7.0	
Hayward–Rodgers Creek: South Section	8.7	6.8	
Hayward–Rodgers Creek: North Section	30.2	6.6	
Calaveras: North	11.6	6.9	25
Calaveras: North, Central	11.6	7.0	
Calaveras: North, Central, South	11.6	7.0	

Table 1-2. Significant Active and Potentially Active Faults

Fault Name	Distance to Faulta (miles)	Estimated Earthquake Magnitudeb	30-Year Probability of Mw >6.7 Earthquakec (percent)
Potentially Active Type B Faults			
Monte Vista-Shannon	7.6	6.5	1
San Gregorio: Connected [d, e]	10.3	7.5	5
Mount Diablo Thrust	21.9	6.7	3
Green Valley Connected [e]	33.3	6.8	7

a. *Fault-to-site distances based on the 2008 updated National Seismic Hazard Mapping program (Petersen et al. 2008) and 2008 National Seismic Hazard Maps: Fault Parameters website (USGS 2018) at https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/.*

b. *Maximum earthquake magnitude: The maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF2007-1437 (Supporting Documentation for the Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2) (WGCEP 2008).*

c. *30-year probability of $M_w \geq 6.7$ earthquake based on 2014 WGCEP (2014 WGCEP 2015b).*

d. *San Gregorio Fault analyzed as a Type A fault by the 2007 WGCEP (WGCEP 2008).*

e. *The term "connected" means that the USGS (WGCEP) analyses of potential rupture and maximum magnitude for that fault is looking at a maximum event (rupture) anywhere along the entire length of the fault (i.e., segments all connected) as opposed to analyses of rupture and magnitude because of earthquake events as related to individual segments of the fault.*

1.1.5 Site Location and Past Use

The site of the Sunnyvale landfill was originally a flat, bayward-sloping plain with the surface elevation at or near mean sea level. In the 1920s, waste material, including municipal waste, construction debris, and non-hazardous industrial and commercial waste was placed directly onto the ground surface. The waste was formed into four hills: West Hill, Recycle Hill, South Hill, and East Hill. Waste was received at the landfill until September 1993, and the landfill was capped in 1994 in accordance with an approved Closure Plan submitted in 1990. The landfill cap consisted of a minimum 4-foot-thick cover (1- to 2-foot foundation layer, 1.0- to 1.5-foot low-permeability clay, and 1.0- to 1.5-foot vegetative topsoil). The topsoil was seeded with native grasses and irrigated (RWQCB 2004).

The landfill is currently in its post-closure monitoring and maintenance phase and is required to comply with many federal, state, and local regulations administered by the U.S. Environmental Protection Agency (EPA), California Air Resources Board, Regional Water Quality Control Board (RWQCB) San Francisco Region, CalRecycle, Bay Area Air Quality Management District (BAAQMD), and Santa Clara County Department of Environmental Health (RWQCB 2004).

1.1.6 Site Conditions

This section describes site conditions, including geotechnical conditions and the hydrogeologic setting.

1.1.6.1 Geotechnical Conditions

Recycle Hill is one of four units of the City of Sunnyvale Landfill and is bounded by the WPCP and associated access and parking area to the north; paved roadways on the east and south sides; and Moffett Channel on the west. Recycle Hill measures approximately 750 feet x 500 feet and 40 feet high. The landfill perimeter is at elevation +2 and rises to elevation +43 feet where a narrow top measures about 20 feet wide x 250 feet long. The landfill side slopes are inclined at about 22 to 25 percent (4:1 slope) and are generally uniform. A narrow dirt track road extends from the northwest corner to the top. The landfill mound is covered with low grasses and enclosed by chain-link fence.

At the Recycle Hill landfill artificial fill is used as cover soil and also underlies the adjacent roadways and parking areas at the WPCP. Geotechnical borings on the north side of Recycle Hill (and throughout the WPCP) indicate that the subsurface soils beneath the landfill consist of medium stiff to very stiff lean clay, sandy clay, and silty clay deposits to depths of 100 feet. One or two thin interbeds (approximately 5 feet thick) of medium-dense to dense silty sand, clayey sand, and poorly graded sand occur below a depth of 35 feet in most borings. Boring logs reviewed are inadequate to interpret the exact depth and thickness of these geologic units beneath Recycle Hill. Geotechnical borings were performed by Fugro Consultants, Inc. (Fugro 2016) and Subsurface Consultants, Inc. (SCI 1992) for the proposed administration building at the north side of the Recycle Hill site. No geotechnical information is available below the existing landfill. Our estimation of the geologic profile at the site based on the limited available data includes a blanket of artificial fill and probable refuse debris outside of the assumed landfill area to depths up to 15 feet below existing grade (SCI 1992; Fugro 2016), overlying predominantly stiff clay deposits to the maximum depth explored of 100 feet.

Artificial Fill (af). The closed landfill mound has a minimum of 4 feet of artificial fill cover (RWQCB 2004). The flat areas surrounding the landfill are underlain by fill to support the local roadways and parking areas in the developed areas. Fill encountered in borings on the north side of Recycle Hill consists of clayey gravel, silty lean clay, and fat clay measuring 4 to 9 feet thick that in turn overlies landfill waste extending to depths of 9 to 15 feet nearest to the north landfill mound (SCI 1992; Fugro 2016).

Bay Mud (Qbm). Holocene-age Bay Mud is mapped north of the site beneath the salt ponds and wastewater oxidation ponds (Figure 1-2; Brabb et al. 2000). The Bay Mud interfingers with and grades into the fine-grained deposits at the distal edges of the Holocene alluvial fans that border southern San Francisco Bay (Brabb et al. 2000). Soft, saturated estuarine mud comprising lean clay, fat clay, and silty clay was not encountered in borings drilled near Recycle Hill, suggesting that Bay Mud deposits do not underlie the project site.

Basin Deposits (Qhb). Basin deposits encountered in the nearby deep geotechnical borings predominantly comprise clay with thin interbeds of fine-grained sand. Lean clay, sandy lean clay, and rare fat clay are generally stiff to very stiff, and locally hard, to the maximum depth of investigation (101 feet) (SCI 1992; Fugro 2014). The thin interbeds of granular soils comprise medium-dense to dense sandy clay, silty sand, poorly graded sand with silt, and minor well-graded sand with gravel. The thickness of the alluvial fan deposits (Qhaf, Qhb) is greater than the exploration depth (100 feet).

1.1.6.2 Hydrogeologic Setting

The site overlies the very northern portion of the Santa Clara subbasin of the Santa Clara Valley Groundwater Basin, Basin 2-9.02 (DWR 2003). The Santa Clara subbasin is within a structural trough parallel to the northwest trending Coast Ranges. The Diablo Range and Santa Cruz Mountains form the basin boundary on the west and east, respectively. The basin extends from the northern border of Santa Clara County to the groundwater divide near the town of Morgan Hill, approximately 25 miles. The valley is drained to the north by tributaries to San Francisco Bay including Coyote Creek, the Guadalupe River, and Los Gatos Creek. Annual precipitation for the Santa Clara basin ranges from less than 16 inches in the valley to more than 28 inches in the upland areas. The water-bearing formations of the Santa Clara subbasin include Pliocene- to Holocene-age continental deposits of unconsolidated to semi-consolidated gravel, sand, silt, and clay. Two members form this group—the Santa Clara Formation of Plio-Pleistocene age and the younger alluvium of Pleistocene to Holocene age (DWR 2003). The younger alluvium is the primary shallow water-bearing deposits of interest in this study. The younger alluvium extends from the ground surface to a depth of approximately 1,000 feet beneath the site. The younger alluvium interfingers with the fine-grained marine clays deposited during the periodic incursions of the San Francisco Bay (McLaren 1987). Figure 1-3 provides a generalized schematic of the aquifer system underlying the site.

Alternating fine- and coarse-grained deposits underlie the site. The coarse-grained water-bearing deposits have been divided into an Upper Aquifer Zone and a Lower (or Deeper, as shown on Figure 1-4) Aquifer Zone based on the conditions of groundwater occurrence. Groundwater-bearing deposits within 100 feet of the ground surface compose the Upper Aquifer Zone and can be confined, semi-confined, and unconfined (McLaren 1987).

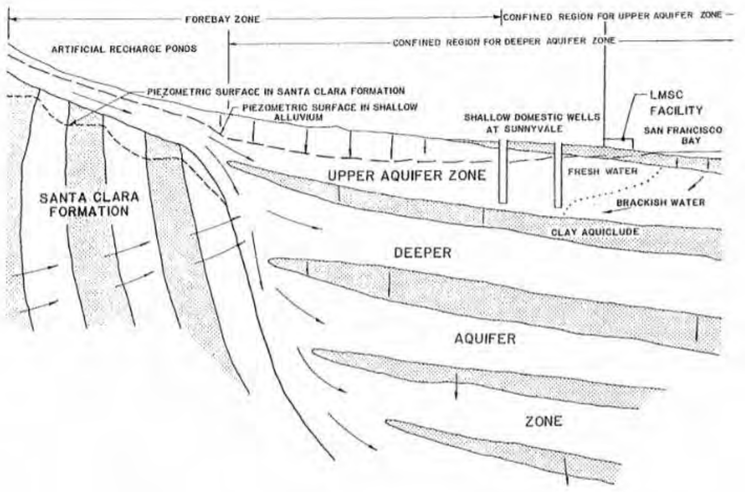

FOREBAY ZONE
CONFINED REGION FOR UPPER AQUIFER ZONE
CONFINED REGION FOR DEEPER AQUIFER ZONE
ARTIFICIAL RECHARGE PONDS
PIEZOMETRIC SURFACE IN SANTA CLARA FORMATION
PIEZOMETRIC SURFACE IN SHALLOW ALLUVIUM
SHALLOW DOMESTIC WELLS AT SUNNYVALE
LMSC FACILITY
SAN FRANCISCO BAY
UPPER AQUIFER ZONE
FRESH WATER
BRACKISH WATER
SANTA CLARA FORMATION
CLAY AQUICLUDE
DEEPER
AQUIFER
ZONE

Figure 1-4. Aquifer conceptual model

Source: McLaren 1987.

Section 2: Site Conditions

This section presents a discussion of the site-specific geotechnical conditions, geologic hazards, and geoenvironmental conditions at the proposed recycled water treatment plant site. This discussion is based on available published geologic reports and geotechnical boring logs for the immediately adjacent administration building (proposed) site and the Sunnyvale WPCP.

2.1 Geotechnical Conditions

Site-specific geotechnical conditions and geohazards are estimated from various sources and presented below. A thorough geotechnical investigation, laboratory testing, and engineering analysis will be required to address these issues and develop recommendations for the design of new facilities.

2.1.1 Strong Ground Shaking

The Recycle Hill site is relatively close to multiple faults as shown on Figure 1-3 and presented in Table 1-2. The closest faults to the site are the Hayward Fault, Monte Vista-Shannon Fault, and San Andreas Fault, which are considered capable of generating earthquakes of M_W 7.3, 6.5, and 7.9, respectively. Strong ground shaking at the site will result from a large earthquake on any of the regional faults presented in Table 1-2.

2.1.2 Fault Rupture

No active or potentially active faults are known to cross the site. Consequently, the hazard posed by ground rupture due to fault offset is considered very low.

2.1.3 Groundwater Depth

Groundwater levels at the northern end of the Recycle Hill site observed during geotechnical drilling (1992 and 2014) vary between approximately 10 and 15 feet below existing grade. Given the proximity of the site to the San Francisco Bay, it is likely that groundwater levels fluctuate with the tides, but with damped magnitude and time delay. Depending on the scope of the proposed improvements, this tidal-groundwater relationship should be evaluated during the design-level geotechnical investigation. Table 2-1 below summarizes the observed groundwater conditions from the SCI and Fugro investigations.

Table 2-1. Summary of Groundwater Readings

Boring	Date of Groundwater Reading	Approximate Ground Surface Elevation (ft)	Approximate Depth to Groundwater[a] (ft)	Approximate Groundwater Elevation (ft)[b]
SCI, TB-6	7/14/1992	3.3[c]	12	-8.7
SCI, TB-7	7/17/1992	3.3[c]	14	-10.7
SCI, TB-8	7/14/1992	3.7[c]	12	-8.3
SCI, TB-10	7/14/1992	3.8[c]	14	-10.2
Fugro, B-12	10/2/2014	107.0 +/-[d]	12.5	-5.5
Fugro, B-13	10/3/2014	107.0 +/-[d]	13.0	-6
Fugro, B-14	Not observed	106.0 +/-[d]	Not observed	NA

a. *Depths given as measured from existing ground surface at time of drilling.*

b. *Approximate groundwater elevation normalized to NAVD88.*

c. *The exact elevation datum used on the SCI boring logs is unknown.*

d. *Datum noted on Fugro boring logs is assumed to be NAVD88 +100 feet, as is common practice at locations where NAVD88 is near 0 ft.*

Groundwater levels are expected to rise commensurate with 2 to 8 feet of sea level rise projections for the San Francisco Bay Area (BCDC 2017) at the site within a 50-year design life. A detailed estimate and discussion of groundwater elevation with respect to sea level rise should be included during future geotechnical analysis of the site addressing specific facilities.

2.1.4 Liquefaction

Liquefaction is a phenomenon wherein a temporary reduction of soil shear strength occurs because of increases in pore pressure that result from cyclic loading of soils during earthquakes. In general, saturated, loose to medium-dense sands and silty sands that are within about 50 feet of the ground surface are most susceptible to liquefaction. Consequences of liquefaction can include:

- Partial to total loss of support for foundations underlain by the liquefied soils
- Sudden and dramatic settlement indicative of bearing failure, with a large differential subsidence and tilting of structures supported above the liquefied layer
- Surface settlements due to volumetric compression of the liquefied layer or due to loss of liquefied material as a result of sand boils or lateral-spreading accompanying liquefaction
- Downdrag forces developed along the sides of deep foundations and below-grade structures due to the settlement of the liquefied layer and any other soil strata present above the liquefied layer
- Lateral spreading of the ground surface where liquefaction occurs on or near slopes causing significant lateral forces on below-grade structures or utilities

The site is located in areas mapped by USGS (Knudsen et al. 2000) and CGS (CGS 2006) as having high susceptibility to liquefaction; however, the USGS/CGS interpretation is not site-specific. The reviewed data do not indicate the presence of sandy soils that are prone to liquefaction. Preliminarily, based on the limited available data reviewed, the site does not appear to be highly susceptible to liquefaction; however, further investigation is required to perform a detailed site-specific liquefaction assessment.

2.1.5 Lateral Spread

Lateral spreading is a liquefaction-induced lateral ground deformation failure in which near-surface soils move down-slope or toward a nearby free face such as a stream channel, embankment, or shoreline. Because of the anticipated lack of a continuous layer of liquefiable soils, the level topography of the site, and the levee confining the site along the east side of the Moffett Channel, our preliminary assessment is that the potential for lateral spreading toward the channel is considered low. Further investigation including an assessment of the levee design and construction is required to confirm this preliminary assessment.

2.1.6 Dynamic Settlement (Densification)

In addition to settlements caused by post-liquefaction volumetric reconsolidation of saturated soils (liquefaction), dynamic settlements due to volumetric contraction (densification) of non-saturated soils (above the water table) may also occur during strong ground shaking. The limited available data reviewed do not indicate a significant potential for dynamic settlement assuming that existing landfill material is mitigated in some manner; however, further investigation is required to confirm this preliminary assessment.

2.1.7 Consolidation Settlement

Consolidation settlements may occur in softer clayey geologic layers with additional fill or structural loads. The magnitude of settlement will depend on the physical extent and geotechnical properties of susceptible layers and may occur over several decades. Reviewed data indicate relatively stiff clays below the existing landfill, showing low potential for significant consolidation settlements; however, further investigation is required to confirm this preliminary assessment.

2.1.8 Landslides/Slope Instability

Assuming that the landfill is removed prior to construction, the relatively flat terrain of the Recycle Hill site is not subject to hazards associated with slope instability or seismically induced landslides.

2.1.9 Tsunami

Tsunami inundation modeling results (CGS 2009) indicate that wave run-up would occur along several of the nearby channels, including Guadalupe Slough. The tsunami models are based on very large earthquake scenarios on nearby sources such as Point Reyes Thrust Fault and Rodgers Creek-Hayward faults, and distant sources, including the Cascadia, Aleutians, and Japan subduction zones. Based on this modeling, the predicted wave run-up extends about 0.7-miles up Guadalupe Slough and does not reach the mouth of Moffett Channel (CGS 2009). Tsunami wave height and predicted run-up should be verified during the geotechnical investigation.

2.1.10 Sea Level Rise

Sea level rise from global climate change is a significant concern for structures built near tidal bodies of water and is additive to other forms of water level rise, such as storm surge, storm waves, tsunami, or El Niño effects. The Recycle Hill site is in the immediate vicinity of tidally influenced channels. Sea level rise inundation maps for Santa Clara County identified that most of the salt pond berms are constructed to elevations higher than mean higher high water (MHHW, extreme tide scenario) +24 inches (BCDC 2017) and generally protect the nearby low-lying areas. However, the MHHW +36-inch scenario results in the salt pond and other levees being overtopped and inundation of the WPCP and commercial areas south of Caribbean Drive. Higher sea level rise scenarios would further impact the project site. Future grading of the site and adjacent levees should consider sea level rise. In addition, sea level rise will likely raise the groundwater level at the site comparable to sea level rise projections of 12 to 36 inches considered reasonable for the San Francisco Bay Area by 2100, although projections near 66 inches are possible (BCDC 2017). Sea level rise effects should be reviewed with current projections during the geotechnical investigation to support planning for the proposed project grade and groundwater levels.

2.1.11 Corrosion

Corrosive soils and corrosive saline groundwater can cause damage to structures, foundations, and buried utilities and can also increase required maintenance. Depending on the degree of corrosivity of subsurface soils, concrete, reinforcing steel in concrete structures, and bare metal structures exposed to these soils can deteriorate, eventually leading to structural failure. Typically, at a site this close to the Bay, uncoated steel may be susceptible to corrosion. Corrosion mitigation measures may be required for any ferrous materials exposed to the surrounding soils (e.g., steel beams, rebar, driven steel H-piles, etc.).

The actual corrosion potential of soils underlying the Recycle Hill site should be evaluated during the final geotechnical investigation.

2.2 Geoenvironmental Conditions

This section summarizes the soil and groundwater conditions (collectively referred to herein as the geoenvironmental conditions) of Recycle Hill and its surrounding areas as they relate to hazardous materials released to the subsurface resulting from historic landfill operations. The summary is focused primarily on groundwater conditions, as there are little data related to the very thin to nonexistent unsaturated zone between the landfill refuse and the groundwater.

The City of Sunnyvale is the owner and operator of record for the Sunnyvale Landfill and currently monitors the landfill under the Sunnyvale Landfill Postclosure Maintenance Plan (SCS 2012). The plan was prepared in accordance with Title 27 of the California Code of Regulations (27 CCR). The monitoring system consists of groundwater monitoring wells used to collected level and water quality data, surface water monitoring points used to measure surface flows and water quality, a leachate monitoring and collection system used to collect landfill leachate and monitor leachate levels, and a landfill gas collection system used to collect landfill gas generated during waste decomposition. Figure 2-1 shows the various Sunnyvale Landfill monitoring station locations, with Recycle Hill outlined with an orange dashed line. San Francisco RWQCB Order R2-2004-0030, adopted May 19, 2004, implements a Corrective Action Program Self-Monitoring Report (CAP SMR) for the Sunnyvale Landfill. The CAP SMR is prepared annually for the landfill to document compliance with the post-closure plan and current site conditions. The principal objectives of the CAP SMRs are to:

- Verify the continued hydraulic capture of groundwater beneath the landfill, as defined in the CAP
- Report the results of field monitoring and laboratory analyses of the physical and chemical characteristics of the groundwater, surface water, and leachate at the landfill

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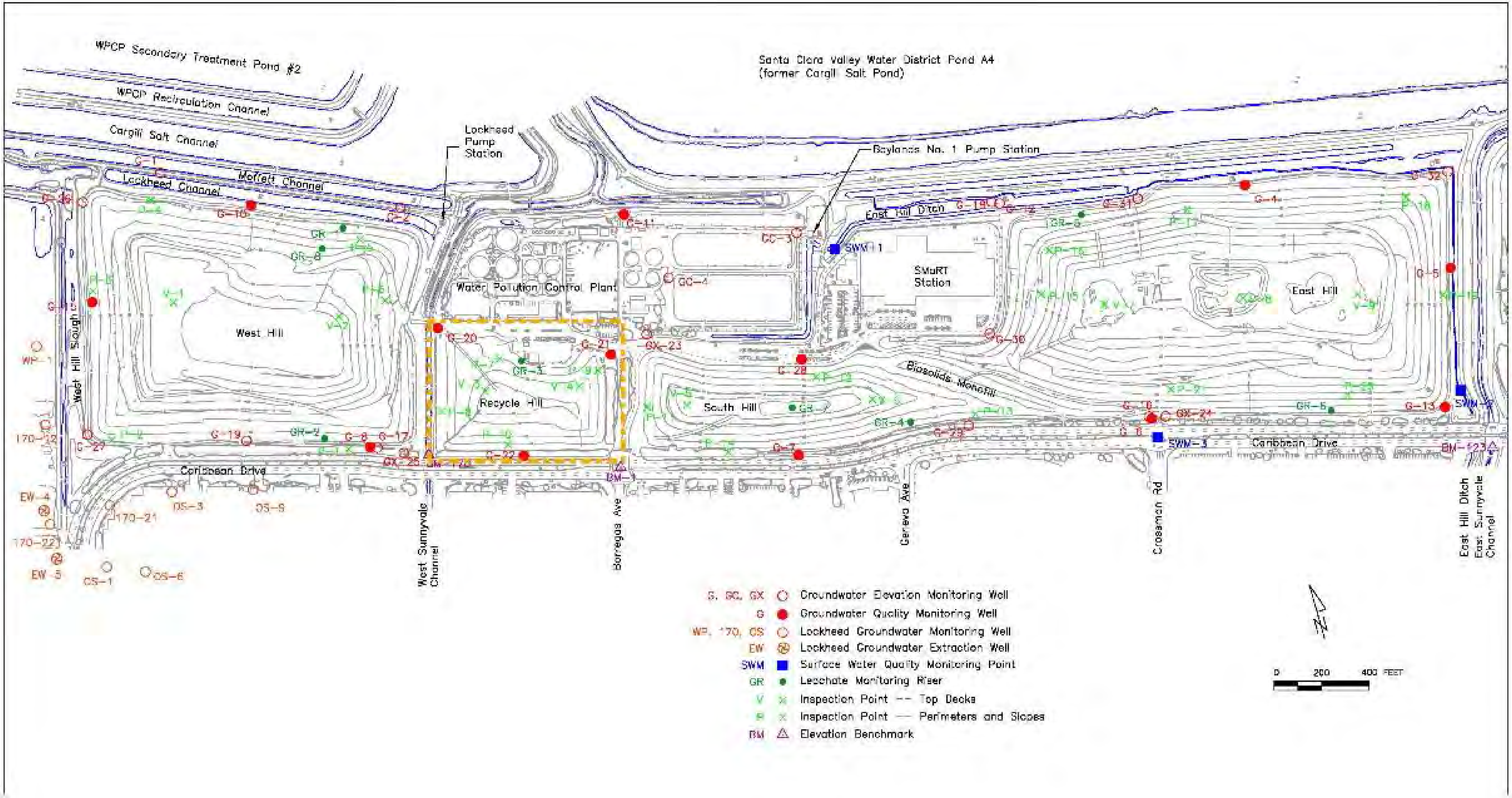
WPCP Secondary Treatment Pond #2
WPCP Recirculation Channel
Cargill Salt Channel
Moffett Channel
Lockheed Channel
Lockheed Pump Station
Santa Clara Valley Water District Pond A4
(former Cargill Salt Pond)
Baylands No. 1 Pump Station
East Hill Ditch
SWM-1
SMaRT Station
Water Pollution Control Plant
West Hill
West Hill Slough
Recycle Hill
South Hill
Biosolids Monofill
East Hill
Caribbean Drive
West Sunnyvale Channel
Borregas Ave
Geneva Ave
Crossman Rd
East Hill Ditch
East Sunnyvale Channel
G-20
G-21
G-22
GX-23
GX-25
G-28
GR-3
GR-4
GR-5
GR-6
GR-7
GR-8
G-10
G-11
G-13
G-19
G-27
G-30
G-31
G-32
GC-2
GC-3
GC-4
GX-24
SWM-2
SWM-3
BM-1
BM-123
WP-1
170-12
170-21
170-22
EW-4
EW-5
OS-1
OS-3
OS-6
OS-9
G, GC, GX ○ Groundwater Elevation Monitoring Well
G ● Groundwater Quality Monitoring Well
WP, 170, OS ○ Lockheed Groundwater Monitoring Well
EW Lockheed Groundwater Extraction Well
SWM ■ Surface Water Quality Monitoring Point
GR ● Leachate Monitoring Riser
V × Inspection Point -- Top Decks
P × Inspection Point — Perimeters and Slopes
BM △ Elevation Benchmark
N
0 200 400 FEET

Figure 2-1. Sunnyvale Landfill monitoring points

Source: Ulrick & Associates 2018.

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2.2.1 Onsite Groundwater Conditions

There are 31 groundwater monitoring wells at the landfill that are used to measure groundwater levels on a semi-annual basis (Ulrick 2018), as shown on Figure 2-1. Thirteen of the 31 wells are included in the water quality monitoring program that is performed on an annual basis (G-4, G-5, G-6, G-7, G-8, G-10, G-11, G-13, G-15, G-20, G-21, G-22, and G-28). The 13 water quality wells are monitored for:

- **Field parameters:** turbidity, electrical conductivity, pH
- **Inorganic parameters:** chloride, chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia, ammonia-nitrogen, total Kjeldahl nitrogen, nitrate + nitrile nitrogen, and total nitrogen
- **Organic parameters:** total phenols, fuel additives (benzene, toluene, ethylbenzene, and xylene [BTEX] and methyl tert-butyl ether [MTBE]), and volatile organic compounds (VOC)

Wells G-20, G-21, and G-22 are along the perimeter of Recycle Hill, and the water level and water quality data from these wells best represent groundwater conditions beneath Recycle Hill. The depth to water and groundwater elevations measured at Recycle Hill during the March 2018 monitoring event (Ulrick 2018) are summarized in Table 2-2 and depicted on Figure 2-2. Groundwater elevations increase during the rainy season because of rainfall recharge and decrease during the dry season due to groundwater discharge to sinks (underlying sewers and storm drains) and to evapotranspiration. Leachate and groundwater elevations indicate either a similar response to rainfall recharge and discharge or some degree of hydraulic communication between leachate and groundwater (Ulrick 2018). Historically, groundwater elevations have remained fairly constant at the Recycle Hill monitoring wells (Ulrick 2018).

Table 2-2. Groundwater Levels at Recycle Hill

Well Number	Date Measured	Datum Elevation (ft NAVD)	Depth to Water (ft)	Groundwater Elevation (ft NAVD)
G-20	3/12/2018	8.99	14.35	-5.36
G-21	3/12/2018	8.97	15.85	-6.88
G-22	3/12/2018	3.65	7.40	-3.75

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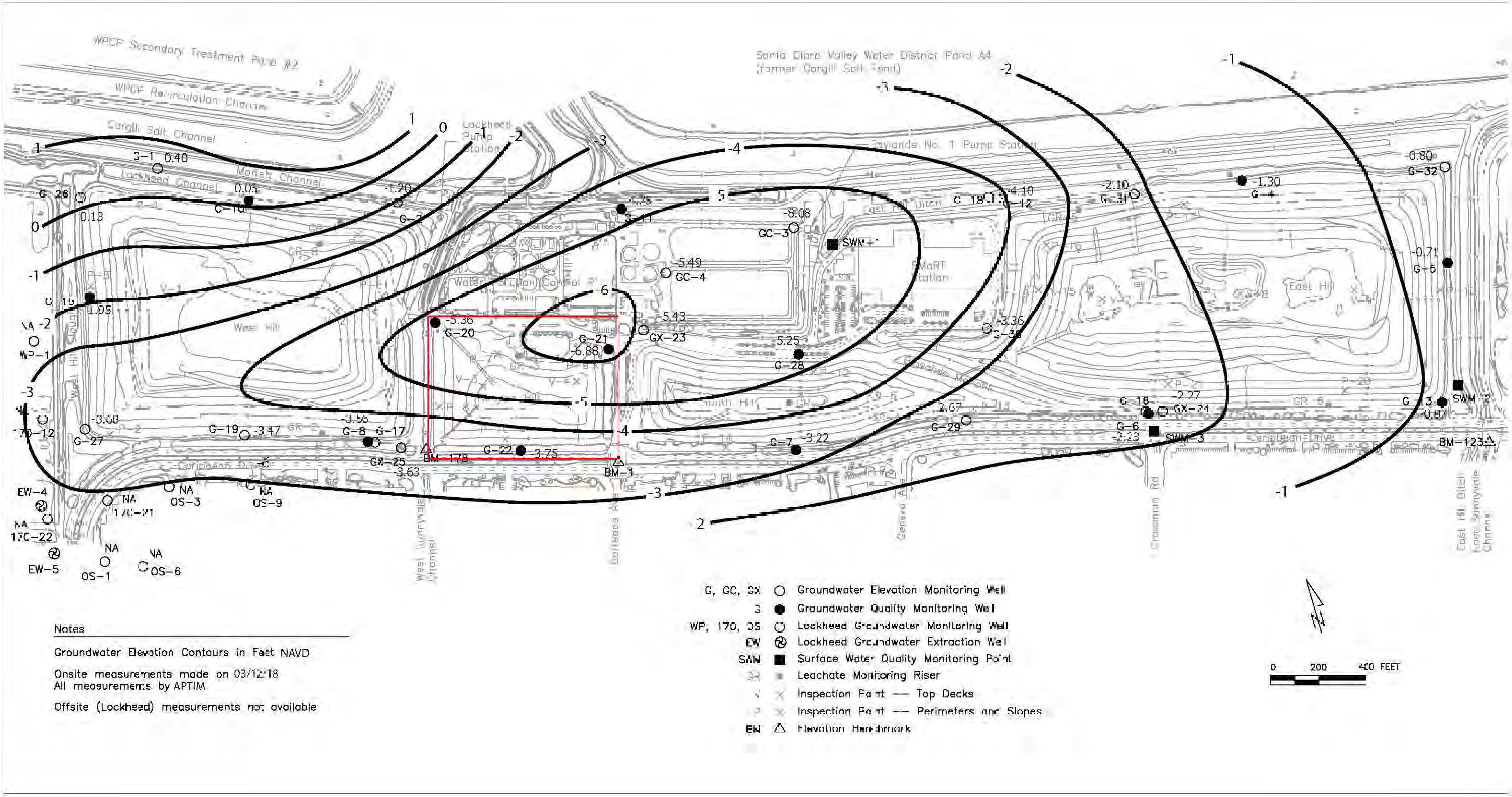

Notes

Groundwater Elevation Contours in Feet NAVD

Onsite measurements made on 03/12/18
All measurements by APTIM

Offsite (Lockheed) measurements not available

G, GC, GX	○	Groundwater Elevation Monitoring Well
G	●	Groundwater Quality Monitoring Well
WP, 170, OS	○	Lockheed Groundwater Monitoring Well
EW	⊗	Lockheed Groundwater Extraction Well
SWM	■	Surface Water Quality Monitoring Point
GR	▪	Leachate Monitoring Riser
V	×	Inspection Point — Top Decks
P	×	Inspection Point — Perimeters and Slopes
BM	△	Elevation Benchmark

Figure 2-2. March 2018 groundwater elevation contours

Source: Ulrick & Associates 2018.

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The primary water quality concerns related to the development of Recycle Hill for a water treatment plant are those chemicals and constituents that can result in exposure levels to human and environmental receptors exceeding regulatory exposure limits during either site construction or operation. It is assumed that constituents currently in groundwater can be accepted into the WPCP, as they currently infiltrate into the underlying sewer system connected to the WPCP, as discussed below. Additionally, the shallow groundwater beneath the site will not be used as a potable water supply, so the exposure to inorganic parameters during site construction or operation pose little threat to human health or the environment. The organic parameters identified above are the focus of this evaluation, as they must be fully assessed to make informed management decisions related to the development of the site.

As discussed above, water quality data are collected from 13 wells on an annual basis. Water quality data for wells G-20, G-21, and G-22 (Recycle Hill wells) are discussed below and summarized in Table 2-3. Note only those organic parameters detected at one or more times above the method detection limit are shown in the table. All other organic parameters have historically been below detection limits.

Table 2-3. Groundwater Quality at Recycle Hill

Well	Constituent	PEL[b]	MCL[a]	Result by Year[a]												
				2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
G-20	1,1-DCA	100	5	0.8	2.4	ND	3.5	2.5	1.1	ND	ND	ND	ND	ND	ND	ND
	cis-1,2-DCE	200	6	ND	0.7	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Vinyl chloride	1	0.5	ND	1.6	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND
G-21	Chlorobenzene	10	NA	1.3	1.1	0.6	ND	1.3	1.0	ND	1.1	1.4	1.8	2.0	2.0	2.0
	Chloroethane	100	NA	ND	ND	1.5	ND	ND	ND	ND	ND	ND	8.3	ND	3.9	ND
	1,4-dichlorobenzene	10	5	0.8	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.9	0.8
	1,1-DCA	100	5	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND
	Vinyl chloride	1	0.5	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
G-22	1,1-DCA	100	5	1.5	1.0	1.2	1.4	1.1	ND	ND	ND	ND	ND	ND	0.9	0.7
	1,1-DCE	1	6	17.0	9.8	17.0	18.6	17.6	8.5	13.8	13.5	13.0	14.2	12.7	13.0	11.0
	PCE	25	5	0.5	0.6	ND	ND	1.3	ND	1.0	1.4	1.2	1.5	1.5	1.6	1.4
	1,1,1-trichloroethane	350	200	1.2	1.4	1.0	1.1	1.2	ND	ND	ND	ND	ND	ND	ND	ND
	TCE	25	5	29.0	2.5	3.8	3.3	3.7	2.6	2.9	3.0	2.8	3.2	3.1	3.4	3.0

Notes:

a. All concentrations are in parts per million

b. All concentrations are in micrograms per liter

PEL: permissible exposure limit to airborne contaminant (expressed as an 8-hour total weight average concentration), Cal OSHA

ND: not detected at or above the method detection limit

MCL: maximum contaminant level for drinking water in California, March 2018

Well G-22 has consistently shown the highest VOC concentrations with trichloroethene (TCE) up to 29 micrograms per liter (µg/L) in 2006, and 1,1-dichloroethene (1,1-DCE) up to 18.6 µg/L in 2009; however, the 2018 monitoring event indicated much lower concentrations of these constituents, with only 3 µg/L TCE and 11 µg/L 1,1-DCE.

2.2.2 Onsite Surface Water Conditions

Three surface water monitoring points, SWM-1, SWM-2, and SWM-3, are used to monitor surface water flows within the East Hill portion of the landfill, as shown on Figure 2-1. Surface water enters the landfill at locations SWM-2 and SWM-3; downstream surface water monitoring point SWM-1 is located near the Baylands Pump Station forebay. Samples are collected from each point on an annual basis (when liquid is present) and analyzed for the parameters listed in Table 2-3 for groundwater. VOCs have not been detected at the surface water monitoring points since 2007.

2.2.3 Onsite Leachate Conditions

A Leachate and Groundwater Management Plan (LGMP) was established at the Sunnyvale Landfill in the early 1990s. The LGMP was undertaken in response to an RWQCB directive to provide an engineered alternative to the 5-foot separation requirement between MSW materials and the highest anticipated groundwater level (RWQCB Order 89-105). The LGMP system consisted of both leachate and groundwater extraction points, and was designed to remove accumulated leachate from the refuse mass, collect groundwater potentially contaminated with landfill leachate, and reduce groundwater elevations below the refuse prism.

The leachate and groundwater extraction points installed for the LGMP remain in place; however, these extraction points are used primarily for liquid-level monitoring and are no longer needed as a primary means for hydraulic control. Hydraulic capture is achieved by groundwater flow toward underground sinks (sanitary sewer and storm drain pipelines that underlie the landfill waste mass (RWQCB 2004, Ulrick 2018). Eight leachate risers extend into rock-lined leachate sumps installed on landfill slopes or on the top decks of the landfill, and completed below waste fill elevations. The leachate risers are designated GR-l through GR-8, with GR-3 monitoring leachate within Recycle Hill, and are shown on Figure 2-1. Leachate levels are monitored on a semiannual basis; leachate quality is monitored annually in accordance with RWQCB Order R2-2004-0030. The same suite of analytical parameters for groundwater are used to analyze leachate.

Leachate quality data for riser GR-3 (Recycle Hill riser) is discussed below and summarized in Table 2-4. Only those organic parameters detected at one or more times above the method detection limit are shown in the table. All other organic parameters have historically been below detection limits.

Table 2-4. Leachate Quality at Recycle Hill

Well	Constituent	MCL	Result by Year												
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GR-3	Chlorobenzene	NA	1	1.2	0.8	1.5	2.4	1.2	2	1.5	2.2	ND	ND	1.2	1.6
	Chloroethane	NA	ND	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	1,4-dichlorobenzene	5	1.3	1.2	0.8	1	ND	ND	1.2	ND	1.4	ND	ND	0.8	1
	1,1-DCE	6	ND	ND	ND	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

ND: not detected at or above the method detection limit.

MCL: maximum contaminant level for drinking water in California, March 2018.

Leachate riser GR-3 has historically had detections of chlorobenzene and 1,4-dichlorobenzene below 3 µg/L. The 2018 monitoring event shows detections of chlorobenzene and 1,4-dichlorobenzene at concentrations of less than 2 µg/L. The California public health goals for chlorobenzene and 1,4-dichlorobenzene are 70 and 6 µg/L, respectively.

2.2.4 Offsite Groundwater Concerns

To determine the groundwater conditions offsite of the Sunnyvale Landfill, the State's GeoTracker website was used. Several sites listed on GeoTracker indicate past and current groundwater contamination. Figure 2-3 shows several sites around Recycle Hill that are in the GeoTracker database. There is also evidence of possible upgradient sources of organic compounds in the groundwater because four of the nine reported groundwater organic compounds detected in the 2018 CAP SMR (Ulrick 2018) for the Sunnyvale Landfill were reported in groundwater only and not in leachate. Four organic compounds are indicators of offsite groundwater contamination because they were detected in groundwater, but not in leachate, including:

- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)

These compounds are known contaminants in the groundwater at the former 141 Caspian Court remediation site (AC BALL MENLO CASPIAN [T0608591628]), located about 400 feet south of the landfill near Borregas Avenue (Figure 2-3). Site cleanup at the 141 Caspian Court site was closed in February 2004.

TCE is a known contaminant in the groundwater at the Lockheed Sunnyvale Plant One Facility (SI1821f605), 1111 Lockheed Martin Way, located south and southwest of the southwest corner of the landfill (Figure 2-3). Contaminants known to exist at the Lockheed site include 1,1,1-trichloroethane, benzene, chromium, gasoline, nitrate, PCE, toluene, TCE, and xylene. A groundwater extraction and treatment system has been in full operation since 1993.

The groundwater flow direction at the Lockheed site is to the northeast toward the landfill (Cameron-Cole 2018). The TCE plume in the shallowest parts of the aquifer (locally known as the First and Second Transmissive Zones) appears to extend beyond the Lockheed site boundary but does not reach beneath Recycle Hill.

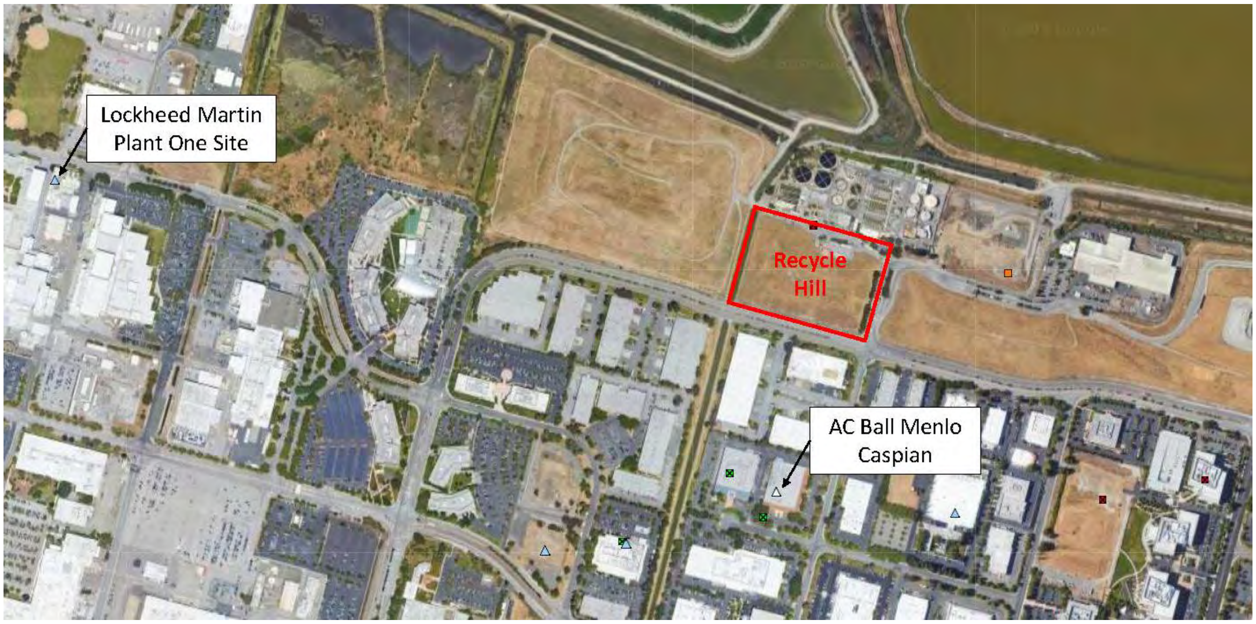

Figure 2-3. GeoTracker search of Sunnyvale Landfill

Section 3: Site Inspection Observations

The landfill mound at Recycle Hill rises approximately 40 feet above the surrounding grade at the margins of the San Francisco Bay where numerous channels feed the southern portion of the bay. Aside from the three other landfill hills adjacent to the site, the area is relatively flat terrain, built out over alluvial fan deposits covered by artificial fill. Background documents noted superficial slope erosion problems on the landfill slopes. These conditions were confirmed during our site reconnaissance; however, no large-scale failures were noted during our site visit.

Section 4: Data Gaps

This section describes geotechnical and geoenvironmental data gaps in the study.

4.1 Geotechnical

The available geotechnical data reviewed were limited to the north side of the Recycle Hill site, at the location of the proposed administration building. Previous studies for this area included seven geotechnical borings as performed by Fugro Consultants, Inc. (Fugro 2014) and Subsurface Consultants, Inc. (SCI 1992). The remainder of the site lacks sufficient geotechnical information that would be required for any large-scale development of the site.

4.2 Geoenvironmental

Geoenvironmental data gaps include current soil and groundwater conditions directly beneath Recycle Hill. Although three shallow groundwater wells along the perimeter of Recycle Hill are monitored annually, soil and groundwater conditions within the main waste area are unknown and could pose exposure to onsite workers during construction and could impact other construction-related concerns, such as waste handling and disposal. These data gaps can be filled during the detailed geotechnical investigation by collecting soil and groundwater samples from the geotechnical borings and analyzing those samples for VOCs and other chemicals of concern.

Section 5: Recommendations for Further Study

This section presents geotechnical and geoenvironmental recommendations for further study.

5.1 Geotechnical

Further geotechnical study consisting of a detailed geotechnical investigation with deep borings is required for any use of the Recycle Hill site related to the design and construction of a reclaimed water facility. It is likely that the existing landfill would be removed as part of the development effort and, as such, the geotechnical investigation should be performed after removal of the landfill to reduce difficulties associated with drilling through an existing landfill site. Geotechnical investigation of the site with the landfill in place will require piercing the landfill cover soils with borings and cone penetration tests (CPT), creating a potential path for landfill leachate or gases to escape the site and/or downward migration of leachate to the water table. If the existing landfill material is not removed prior to site work, the recommendations in this GTM and attached Geotechnical Exploration Plan (GEP) would need to be modified accordingly.

Difficulties associated with drilling through the landfill waste include but are not limited to (1) additional permitting for drilling through an existing closed landfill, (2) additional safety concerns associated with active drilling on a landfill that may produce toxic and explosive gases during the drilling process, (3) access for drilling equipment on landfill slopes, and (4) mitigation measures and repairs to the landfill facilities after geotechnical investigation.

The specific scope of the geotechnical investigation should be determined after a basic development scheme and layout is developed for the recycled water facility, and a site-specific GEP is developed after recycled water facilities options have been evaluated. Generally, the exploration plan may include:

- Drilling and sampling of six to eight geotechnical borings to collect disturbed and undisturbed samples, and completion of four to six CPTs to depths of 150 to 200 feet.
- A comprehensive laboratory test program to evaluate the engineering properties of the soils, including corrosion potential.
- Preliminary exploration at the four corners of the site may be performed prior to landfill removal. Each exploration point should include a minimum of one geotechnical boring to approximately 150 feet in depth. These borings may be used to broadly characterize the site and aid in preliminary design of site facilities while landfill removal is in progress. The preliminary geotechnical work should include recommendations for placement of compacted fill within the area of landfill removal.
- After landfill removal and preliminary design of site facilities, a detailed geotechnical exploration program may be developed for the site to provide information specific to the facilities. This exploration would likely consist of up to four additional deep borings and four to six CPTs.

The exploration plan and geotechnical investigation should be developed to address liquefaction, shallow groundwater (including tidal influence and sea level rise), soil corrosion potential, lateral spreading, settlement, seismic design, foundations for shallow and deep structures, and support of pavement areas. Deep foundations, such as driven piles, cast-in-hole caissons, or auger cast piles may be required to support large, heavy facilities. Geotechnical recommendations for the backfill of the excavation created by the landfill removal should be developed during the planning phase for landfill removal.

5.2 Geoenvironmental

The Geoenvironmental data gaps at Recycle Hill include soil and groundwater data beneath the central portion of the site. The shallow groundwater around the site perimeter is monitored annually from wells G-20, G-21, and G-22 for the constituents discussed in Section 2.2.1 and additional sampling from these wells is not necessary; however, the soil and groundwater beneath the central portion of the site will require additional sampling to determine conditions that may pose an environmental risk during future site development.

There are two primary concerns related to the soil and groundwater beneath the site, 1) the potential exposure of site workers to chemical hazards, and 2) the handling and disposal of soil and groundwater waste during site development. To address these concerns, the condition of the soil and groundwater must be understood to the total depth of the site-development activities. For example, should site excavation or foundation drilling be necessary, the site developer should know what chemicals are present, at what concentration, and to what depth. Because we don't currently know the depth to which site development activities will occur, we recommend a depth of 25 feet below ground surface be assessed for chemical constituents in the subsurface.

Because of the shallow groundwater at the site (typically less than 10 feet below grade), there are limited vadose zone soils to assess; however, soil samples should be collected from the ground surface to the groundwater interface at 5-foot intervals and submitted for chemical analysis for the constituents identified in Table 5-1, and any other constituents not listed in Table 5-1 that are detected during the landfill removal operations. The shallow soil samples should be collected from the geotechnical borings using split-barrel samplers in accordance with ASTM standards D1586 and D4547.

Shallow groundwater around the perimeter of the site is currently monitored in accordance with the post-closure maintenance plan (SCS 2012), as discussed in Section 2.2.1. Shallow groundwater conditions beneath the central portion of the site need to be assessed to demonstrate a complete understanding of the shallow groundwater conditions that may affect site development (i.e., site dewatering). As such, one shallow monitoring well in the central portion of the site, installed as part of the geotechnical investigation, should be sampled and analyzed for the same constituents as the annual post-closure groundwater monitoring program, and any other constituents that are identified during the landfill removal operations. Together with the three existing site groundwater monitoring wells, the site groundwater conditions can be fully assessed.

Table 5-1. Geoenvironmental Soil and Groundwater Analytical Recommendations

Media	Analyses
Soil	• Metals • Hydrocarbons (total volatile and semi-volatile) • Gasoline range organics and diesel range organics • Pesticides • Polychlorinated biphenyl (pcb) • Others, as identified during landfill removal operations
Groundwater	• Inorganic parameters: chloride, COD, BOD, ammonia, ammonia-nitrogen, total Kjeldahl nitrogen, nitrate + nitrile nitrogen, and total nitrogen • Organic parameters: total phenols, fuel additives (BTEX and MTBE), and VOCs • Others, as identified during the vadose zone soil sampling and landfill removal operations

Section 6: Closure

The conclusions and recommendations presented herein are based on evaluation and interpretation from review of available relevant past subsurface investigations conducted at the project site. These conclusions and recommendations are intended to be used solely by Valley Water and its consultants in the evaluation of the Recycle Hill site.

This report is based on the data available at the time of completion, and the project as described. Should additional data become available, these conclusions and opinions would need to be reassessed.

The discussion and conclusions presented in this report are professional opinions based on our understanding of the proposed project. The findings and professional opinions presented in this report are presented within the limits prescribed by the client, in accordance with generally accepted professional engineering and geologic practices. There is no other warranty, either express or implied.

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Attachment A: Geotechnical Exploration Plan

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GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

GEOTECHNICAL AND GEOENVIRONMENTAL EXPLORATION PLAN
PROPOSED RECYCLED WATER PLANT
SUNNYVALE, CALIFORNIA

September 2018

Prepared for:

Brown and Caldwell
201 N Civic Drive #300
Walnut Creek, CA 94596

Owner:

Santa Clara Valley Water District
San Jose, CA

GTC Project No. SF18011

TABLE OF CONTENTS

1.0 INTRODUCTION AND PURPOSE 1
2.0 SITE SETTING 3
3.0 GEOLOGIC SETTING AND KEY GEOTECHNICAL/GEOLOGICAL ISSUES 3
  3.1 Geologic Setting 3
  3.2 Key Geotechnical/Geologic Issues 3
4.0 INVESTIGATION WORK SCOPE 4
  4.1 Geotechnical/Geological Investigation Work Scope 5
    4.1.1 Geotechnical Borings 6
    4.1.2 Laboratory Testing 6
5.0 GENERAL FIELD PROCEDURES AND DOCUMENTATION 7
  5.1 Permits and Coordination 7
  5.2 Traffic Control 7
  5.3 Utility Clearance 7
  5.4 Health and Safety 7
  5.5 Daily Field Reports 8
6.0 BORING PROCEDURES 8
  6.1 Preparation and Restoration of Boring Sites 8
  6.2 Drilling 8
  6.3 Logging 8
  6.4 Sampling and Description of Soil 9
  6.5 Sampling and Description of Rock 10
  6.6 Boring Completion 10
  6.7 Piezometer Installation 11
  6.8 Drill Cuttings 11
7.0 CONE PENETRATION TESTS (CPTS) 11
8.0 SCHEDULE 12
REFERENCES 13

FIGURES

Figure 1 Proposed Exploration Plan 2

APPENDICES

Appendix A Daily Field Observation
Appendix B Boring Sampling and Logging Forms
Appendix C Field Logging and Classification of Soil

1.0 INTRODUCTION AND PURPOSE

The work to be performed under this geotechnical and geoenvironmental exploration plan (GEP) is to carry out a geotechnical and geoenvironmental investigation to support the design and construction of proposed recycled water treatment facilities at Recycle Hill (the Site), adjacent to the Sunnyvale Water Pollution Control Plant (WPCP). The proposed recycled water facilities may be located adjacent to a proposed new WPCP administration building at the same site. The contents of this GEP should be modified, as necessary, to accommodate the design of future facilities as the overall planning and conceptual layout of the facilities progresses.

This GEP has been prepared under our geotechnical services task order under contract with Brown and Caldwell (BC) for the Geotechnical Preliminary Study: Recycle Hill, Subtask 3.2 of the Countywide Water Reuse Master Plan (CWRMP) project. The investigation addressed in this plan is intended to gather the necessary information and data to satisfy the following primary objectives:

- Provide geotechnical and geoenvironmental parameters for our site evaluation;
- Assess any potential geologic hazards at the site including strong ground shaking, liquefaction, lateral spread, and dynamic settlement, and;
- Develop foundation recommendations to support the design of new foundations as necessary.

This GEP provides: 1) the scope of the field exploration work, 2) the terms and procedures for logging, sampling, and analysis of soil encountered, and 3) disposal of investigation derived waste. This GEP also describes general field procedures and documentation, including:

- Permits and coordination
- Traffic control
- Utility clearance
- Daily field reports

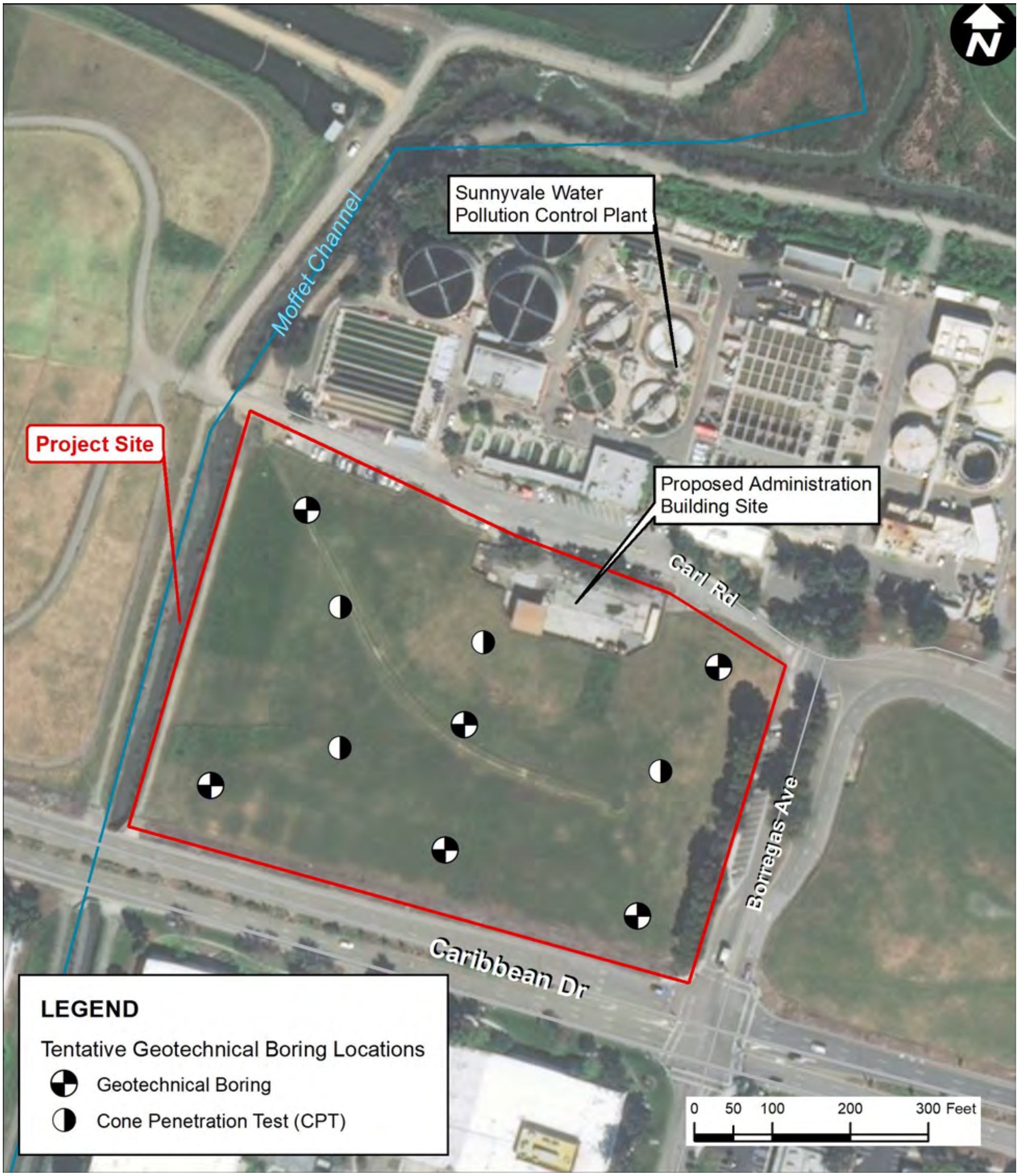
N
Sunnyvale Water Pollution Control Plant
Moffet Channel
Project Site
Proposed Administration Building Site
Carl Rd
Borregas Ave
Caribbean Dr
LEGEND
Tentative Geotechnical Boring Locations
Geotechnical Boring
Cone Penetration Test (CPT)
0
50
100
200
300 Feet

Figure 1 – Proposed Exploration Plan

2.0 SITE SETTING

The project location is known as Recycle Hill and is one of four mounds of the closed Sunnyvale Municipal Landfill. The GEP anticipates the landfill waste, cover soils, and various appurtenances (leachate and gas collection systems) will be removed prior to site investigation activities. The general area is generally flat-lying except for the landfill mounds and the channel levees along the Moffett Channel located on the west side of the site.

3.0 GEOLOGIC SETTING AND GEOTECHNICAL/GEOENVIRONMENTAL ISSUES

3.1 GEOLOGIC SETTING

The project site at Recycle Hill is located at the north end of broad alluvial fans that slope gently to the north from highland areas surrounding the southern Santa Clara Valley. The Holocene age alluvial deposits formed on a broad flat plain at the margin of San Francisco Bay are distinctly fine-grained sand, silt and clay and referred to as alluvial fan and basin deposits (Brabb etal, 2000). The site is underlain by silty clay fan deposits that merge northward (and locally overlie) with estuarine organic clay and silty clay generally referred to as Bay Mud. The alluvial fan basin deposits in the project area contain carbonate nodules or concretions and iron staining indicative of the mixing of fresh water and seawater at the bay margin interface (Brabb etal, 2000). Basin deposits are very fine silty clay deposits that reached the distal edge of the alluvial fan.

The project site is bounded on the west by artificial levees that border Moffett Channel that drains northward between salt ponds to reach Guadalupe Slough. Recycle Hill is a 40-foot high mound representing one of four cells of the closed City of Sunnyvale municipal solid waste landfill. Nearby geotechnical borings encountered 9 to 14 feet of artificial fill overlying lean clay, lean clay with sand, and sandy lean clay. The clay deposits represent the Holocene distal alluvial fan deposits (SCI, 1992; Fugro, 2016). Soft bay mud was not encountered in these borings located on the north side of Recycle Hill or in borings located 500 feet north within WPCP (Fugro, 2016).

3.2 GEOTECHNICAL/GEOENVIRONMENTAL ISSUES

Given the project site geologic setting and engineering objectives, the Project may be exposed to potential geologic/seismic hazards and design challenges that will require evaluation during the investigation. Based on our understanding of the proposed project and the conditions at the project site, the following key geotechnical/geoenvironmental issues have been identified:

- Potential geologic and seismic hazards including strong ground shaking, liquefaction, and dynamic settlement;
- The presence of loose and undocumented artificial fill;
- The presence of weak clay layers;
- The presence of saline groundwater;
- Control of shallow groundwater in excavations or deep foundation boreholes;
- Mitigation of potentially corrosive soils;
- The presence of potentially hazardous chemicals in the subsurface soils and groundwater.

To address these issues, the primary objectives of the proposed study and laboratory testing program are to:

- Collect subsurface information necessary for design of the proposed structures. Identify index (classification) and engineering properties of soils for use in development of geotechnical design parameters including bearing capacity, lateral earth pressures, base and wall friction, side resistance and end bearing for drilled shafts, etc.;
- Collect samples for corrosion testing;
- Identify subsurface conditions that may affect excavation and drilling of deep foundation boreholes or driving piles, including areas of soft, loose, or otherwise potentially-unstable soils; and high groundwater, and;
- Identify depth to, and thickness of, dense bearing stratums for the planning and design of deep foundation schemes;
- Collect soil and groundwater samples to assess the presence of potentially hazardous chemical concentration that could impact site development activities.

The scope of the field investigation and laboratory testing program described in the following sections has been developed to accomplish the objectives summarized above. The overall study consists of researching available data, conducting field investigation activities, performing laboratory tests, and developing and analyzing data.

4.0 INVESTIGATION WORK SCOPE

The field investigation program will consist of up to 4 to 6 cone penetration tests (CPTs) and 6 to 8 borings to maximum depths of 150 to 200 feet, the collection of soil and groundwater samples, and associated field and laboratory tests to obtain necessary data to support the evaluation of the site and design of proposed facilities. The approximate boring and CPT locations are shown on ***Figure 1 – Proposed Exploration Plan***. The details of the exploration program, including the location of the borings, permit requirements, and sampling schedule, are discussed in the following sections.

The investigation work to be carried out will consist of:

- ***Drilling:*** A total of 6 to 8 borings are planned to characterize soil and groundwater conditions across the site. Locations as shown may be refined through further planning of the proposed site facilities. The depth at which groundwater is encountered will be noted on the borehole logs. Groundwater levels will be estimated during drilling. Borings not converted to piezometers will be backfilled with cement grout. Asphalt surfaces will be repaired with cold patch asphalt or concrete as appropriate.

- ***Sampling:*** Samples of soil and consolidated formation will be logged by an experienced engineer or geologist. Soil samples will be obtained for visual classification and laboratory testing using standard penetration testing (SPT) split spoon or modified California drive samplers, or relatively undisturbed thin-walled Shelby tube samplers as appropriate. Sampling will typically be done at 5-foot intervals.

- ***Piezometers:*** Piezometers will be installed in both the shallow and deeper aquifer units beneath the site to monitor seasonal and tidal fluctuations in groundwater levels. A minimum of three deep soil borings will be converted to piezometers, and a minimum of one shallow piezometer will be installed at the center of the site for environmental sampling of groundwater. The central shallow piezometer will supplement the data generated from existing shallow piezometers G-20, -21, and -22. Details of piezometer installation including the quantity, depth and design will be determined in the field based on observed site conditions and project requirements. Groundwater samples from piezometers will be collected as appropriate for the geoenvironmental analysis.

- ***Cone Penetration Testing*:** A total of 4 to 6 CPTs are planned to supplement the boring exploration to characterize soil and groundwater conditions across the site. The proposed approximate locations of the CPTs are shown on ***Figure 1***. Locations as shown may be refined through further planning of the proposed site facilities.

- ***Geotechnical Laboratory Testing:*** Select soil samples will be tested in a geotechnical laboratory for index properties and physical characteristics including Atterberg limits, grain size distribution, moisture content, unit weight, swell pressure, consolidation, shrink-swell potential, shear/compressive strength among other tests dependent on project requirements and soils encountered. In addition, select samples will be tested for their corrosion potential towards concrete and ferrous metals.

- ***Geoenvironmental Laboratory Testing:*** Select soil samples will be tested for the following constituents: metals, hydrocarbons, gasoline range organics, pesticides, PCBs and others as identified during landfill removal operations. In addition, groundwater will be sampled from shallow piezometers and tested for organic and inorganic parameters associated with the landfill removal process. A detailed geoenvironmental testing schedule is outlined in Section 5.2 of the attached Technical Memorandum 3.2.

5.0 GENERAL FIELD PROCEDURES AND DOCUMENTATION

This section describes the procedures that will be used to accomplish the field program for the Project. Permits, procedures for utility clearances, safety of field personnel, environmental monitoring, reporting of daily activities, restoration of exploration sites, and borehole logging are described.

5.1 PERMITS AND COORDINATION

The boring locations will be located within the Recycle Hill site. Soil boring / well permits for the subsurface exploration program will be obtained from Santa Clara County including necessary SCVWD permits. With geotechnical borings occurring after removal of the landfill material, additional permits related to landfill drilling are not anticipated.

5.2 TRAFFIC CONTROL

Traffic control is not anticipated as each boring or CPT will be located within the Recycle Hill project site.

5.3 UTILITY CLEARANCE

The borings will be located in areas having the greatest potential for clearance from overhead and underground utilities. All boring locations will be clearly marked with white paint or white stakes. If underground utilities are anticipated in the vicinity of a marked boring, a private utility locator service will be called on site to locate and delineate underground utilities so that the boring can be cleared or relocated as necessary. Underground Services Alert (USA) will be notified of the field activities approximately 1 week prior to the start of the work. As a further degree of safety, all borings where utility conflicts are suspected will be hand augered to at least 5 feet below existing grade to avoid drilling through any unlocated or miss-located utility.

Site plans showing proposed boring locations should be submitted to the City of Sunnyvale for review and clearance at least 1 week prior to drilling. Drilling will commence only after receiving clearance from the private subsurface utility locator, USA, and permitting agencies.

5.4 HEALTH AND SAFETY

All work performed will comply with the Project-specific Site Health and Safety Plan (HASP), to be developed with the project team and the project Owner. Special consideration for the nature of the decommissioned landfill site may be required when developing the HASP.

5.5 DAILY FIELD REPORTS

Daily Field Reports (DFR) will be prepared to document fieldwork. All reports will be prepared on standardized DFR forms (see sample form in Appendix A). The following information should be included as appropriate in the entries: Project number and task designation; date; Project name; field activity/work performed; location; weather; names of field personnel on site and observers (i.e., clients, technical persons from other firms, county representatives, etc.); completed safety tailgate meetings; supplies used (such as casing, cement, mud, etc.); and other pertinent information (e.g., difficulties, unusual or unexpected conditions).

6.0 BORING PROCEDURES

Borings will be used to explore subsurface conditions within the Project site and to obtain samples for laboratory testing. Locations of the borings are shown on ***Figure 1***. The general procedures for logging and sampling the borings are described below.

6.1 PREPARATION AND RESTORATION OF BORING SITES

In general, borings will be located near to those indicated in ***Figure 1***, or as relocated after preliminary facility layouts are developed. Locations will be selected to maximize the safety of field crews and to minimize impacts on existing site facilities, site access, drainage, landscaping, and native vegetation.

Borings will be backfilled with cement grout. Asphalt surfaces will be repaired with an asphalt cold patch or grouted to the surface as appropriate. The pavement surface will be swept clean.

6.2 DRILLING

Borings within the Project site will be drilled using either mud-rotary or sonic drilling equipment. Drilling fluid will be used during mud-rotary operation.

6.3 LOGGING

All borings will be logged by or under the direct supervision of a Professional Geologist or Professional Engineer registered in the State of California. The geologist/engineer will record daily activities and document significant field observations on a daily field log (refer to Appendix A). The geologist/engineer will log the drill-holes on a field log (see Appendix B) in accordance with the guidelines for soil and/or rock logging presented in Appendix C and D of this document; these guidelines are based on information contained in field manuals developed by the U.S. Bureau of Reclamation (1998) and by Caltrans (1995). During drilling operations, sample depths will be recorded in Imperial units.

All the information in the title block of the boring log will be filled out (refer to Appendix B). The ground surface elevation at the top of borehole will be estimated at the time of drilling, and updated after a field survey is completed. Ground surface elevation can be estimated from existing topographic maps or referenced to a permanent marker in the field. Estimates of elevation should be made to the nearest 2 feet. If an estimate is made, it should be so noted on the logs as such. The boring log title block requires the name of the drilling company. Names of the drill rig crew will be noted on the DFR. In addition, the starting and ending time of the boring will be recorded in the remarks column.

The depth where groundwater is first encountered while drilling, and the depth at the completion of drilling, will be recorded on the log.

6.4 SAMPLING AND DESCRIPTION OF SOIL

Soil will be sampled by either drive sampling or push sampling. Soil samples will be described according to Appendix C – Field Logging and Classification of Soil. When a hammer is used to drive the sampler, the following information will be recorded: delivery system; sampler size; whether or not inner brass tubes are used; and blow counts (recorded in 6-inch intervals). Whenever possible, a safety hammer will be used when driving samplers and measuring blow counts. When push sampling, Shelby or Pitcher tube size and maximum downfeed pressure (read from gauges on the drill rig) should be recorded. In all cases, the amount of sample recovery should be noted.

Typically, samples will be taken at 5-foot intervals throughout the total depth of the boring. In zones where the soil is transitioning from fill material to native soil, or between native soil formations, the sampling interval will be reduced if necessary to characterize the transition zone. Some borings may require different sampling intervals. To the extent possible, modified California Samplers (2 ½ inch ID, 3 inch OD, with liners) and/or Shelby tubes (3 inch OD) will be used to sample cohesive soils. The standard penetration sampler (1.375 inch ID, 2 inch OD, without liners) will be used in cohesionless soils.

Modified California drive and standard penetration (SPT) samplers will be driven into the soil with a 140 lb automatic trip hammer falling 30 inches in general accordance with ASTM 1586. The sampler will be driven 18 inches or to “refusal” (50 blows for less than 6 inches penetration). The blow counts for the final 12 inches of the drive, or portion thereof, will be recorded in the field log.

All samples will be clearly labeled with the following:

- sample number
- job number
- borehole number
- date and time collected
- initials of person collecting the sample.

The sample numbering system consists of two numbers. The first number refers to the sampling interval number. The sampling interval number refers to the driving of the SPT or modified California samplers 18 inches or a portion thereof, or the pushing/drilling of Shelby/Pitcher sampler. These will be numbered consecutively from the top of the borehole to the bottom (Appendix B). Sampling intervals will be numbered even if there is no recovery.

The second number is only used when brass or stainless steel liners are used in the sampler; it refers to the tube number in the sampler. The second number typically applies to the modified California samplers (may also be used for an SPT sampler with liners). For a 24-inch sampler, the liner tube closest to the shoe of the sampler is referred to as tube No. 4. The tubes above it are then labeled consecutively upward as 3, 2, and 1. Although most modified California samplers use three 6-inch tubes, there are some that use four.

6.5 SAMPLING AND DESCRIPTION OF ROCK

Rock is not expected at the Recycle Hill site. Should cemented layers be encountered, we will obtain samples using either soil sampling methods, or a Pitcher barrel sampler, which retrieves a core sample in a 3 inch OD steel liner very similar to a Shelby tube liner.

6.6 BOREHOLE COMPLETION

Unless converted to a piezometer, boreholes will be backfilled with cement grout. The grout mixture will meet the requirements of the local agency. If groundwater is encountered in the borehole, grout will be placed using the tremie method. The tremie method involves pumping grout through the drill rods or a tremie pipe to the bottom of the hole. The drill rods and/or auger/casing will be removed as grout is being pumped; the bottom of the drill rods/casing must be submerged in the grout at all times. The removal of the rod/casing should not begin until grout comes out the top of the borehole. Normally, grout should be tremied through the drill rods or tremie pipe via the drill rig pumping system. In the absence of a pump on the drill rig, the grout will be tremied through a PVC pipe that extends to the bottom of the hole. The grout will be funneled into the top of the PVC. After grouting is complete, the upper 6 to 12 inches of the borehole will be finished with native soil, cold patch asphalt, or quickrete as appropriate. The borehole should be checked in a day or two to make sure it has not settled significantly, and if it has, it will be restored to existing grade.

6.7 PIEZOMETER INSTALLATION

Piezometers will be installed in accordance applicable regulations, and will consist 2-inch diameter, Schedule 40 PVC well casing and screen (factory slotted with 0.02-inch-wide slot size), with No. 3 sand (or approved alternative) filter pack placed within the annulus of the screened interval of the borehole. The screened interval will be isolated from the rest of the boring by a bentonite seal to ensure that the screened interval monitors only the desired groundwater zone. The borehole above the bentonite seal will be filled with grout to the ground surface. The piezometer casing will be installed below the adjacent ground surface. The piezometer will have a locking cap and will be installed with a traffic-proof Christy Box for a “flush-mount” finish, or a steel locking riser casing for “above-ground” finish.

6.8 DRILL CUTTINGS

Drill cuttings and drilling fluid will be stored in 55-gallon steel drums or larger temporary storage bins pending testing, pick-up, and proper disposal by an environmental waste subcontractor. The subcontractor will determine appropriate testing protocol to facilitate disposal. Drums will be labeled with drill-hole number, date, and initials of rig geologist or engineer.

7.0 CONE PENETRATION TESTS (CPTS)

Cone Penetration Tests (CPTs) will be completed by a CPT subcontractor and will follow standard ASTM D5778 procedures. The test is carried out by first pushing the cone, which consists of a stainless steel probe comprising a cone tip and a friction sleeve, into the ground at a standard velocity of 1 to 2 cm/s. The cone takes measurements of cone tip bearing (qc), sleeve friction (fs) and penetration pore water pressure at 5- cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time and the tip and sleeve resistance parameters are stored electronically for further analysis and reference.

The cone also contains a porous filter element located directly behind the cone tip which is used to obtain penetration pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration in order to estimate groundwater piezometric pressures at any depth.

When the soundings are complete, the test holes will be grouted. The grouting procedures generally consist of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. The top of the CPT hole will be finished with either a concrete or asphalt surface patch, or with native soil as appropriate.

8.0 SCHEDULE

The field investigation schedule will be determined at a later date pending decisions regarding site development and use. It is anticipated that each boring may be drilled in one to one and a half days, and that CPTs may be pushed at a rate of up to 4 per day. After permits are in place, and drill rig availability is confirmed, a detailed work schedule will be prepared and submitted to the Project Team. Daily field activities involving heavy drilling equipment are planned for Monday-Friday, between approximately 7:00 am to 5:00 pm. After completion of field work, it is anticipated that laboratory testing will take approximately one month to complete.

All exploration results, laboratory test results and geotechnical/geoenvironmental summaries of the data should be presented in a final report. The final reports should also include geotechnical and geoenvironmental recommendations that support the foundation design and construction of the proposed facilities.

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Appendix F: Conceptual Alternatives

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75 E Santa Clara Street, Suite 375
San José, CA 95113
408.703.2535

Technical Memorandum

Prepared for: Santa Clara Valley Water District (Valley Water)

Project title: Countywide Water Reuse Master Plan

Project no.: 4821 (Valley Water); 151772 (BC internal)

Contract no.: A4120A

Appendix F

Subject: Conceptual Alternatives

Date: October 9, 2018 (reissued June 30, 2020)

To: Miguel Silva, Valley Water Project Manager

From: Jenny Gain, P.E., Brown and Caldwell Team Project Manager

Copy to: David Tucker, Valley Water Assistant Project Manager

Prepared by: Melanie Holmer, P.E., Brown and Caldwell
California License C63236

Curtis Lam, P.E., HydroScience Engineers
California License C59049

Reviewed by: Brett Farver, P.E., Brown and Caldwell
California License C58466

Brian Pecson, PhD, P.E., Trussell Technologies
California License C80440

Limitations:

This document was prepared solely for Valley Water in accordance with professional standards at the time the services were performed and in accordance with the contract between Valley Water and Brown and Caldwell dated January 25, 2018. This document is governed by the specific scope of work authorized by Valley Water; it is not intended to be relied upon by any other party except for the partners, regulatory agencies, and stakeholders contemplated by the scope of work. We have relied on information or instructions provided by Valley Water and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

Table of Contents

Executive Summary 1

Section 1: Introduction 8

Section 2: Market Assessment 9
2.1 Long-term NPR Demands 9
2.2 Identifying the Optimal NPR/PR Split 12

Section 3: Conceptual Alternatives Development 13
3.1 Process 13
  3.1.1 Guiding Principles 13
  3.1.2 Basis for Conceptual Alternatives 14
3.2 Potential Project Elements 14
  3.2.1 Intertie Opportunities 19
3.3 Conceptual Alternatives 19
  3.3.1 Alternative 1: IPR via GWR (from SJ/SC) and Expanded NPR 23
  3.3.2 Alternative 2: IPR via GWR (from Palo Alto/Sunnyvale) and Expanded NPR 26
  3.3.3 Alternative 3: IPR via GWR (from Palo Alto and Morgan Hill) and Expanded NPR 28
  3.3.4 Alternative 4: IPR via GWR (from Palo Alto/Sunnyvale and Morgan Hill) and Expanded NPR 31
  3.3.5 Alternative 5: IPR via GWR (from Morgan Hill), DPR via raw water augmentation (from SJ/SC), and Expanded NPR 34
  3.3.6 Summary 36

Section 4: Process for Prioritization and Assessment 37
4.1 Methodology 37
4.2 Criteria and Weighting 38
4.3 Ranking 38

Section 5: Outcomes of Alternatives Ranking and Selection 38
5.1 Conceptual Alternatives Evaluation 38
5.2 Feasible Alternatives Selection 44

Section 6: Next Steps 44

References 45

Attachment A: Market Assessment .... A

Attachment B: NPR+ Multiplier Calculations .... B

Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

List of Figures

Figure ES-1. Process used to develop conceptual alternatives 2
Figure 2-1. Partner Agencies' service area boundaries 11
Figure 2-2. Flows considered for NPR/PR split 12
Figure 3-1. Process used to develop conceptual alternatives 13
Figure 3-2. GW subbasins and recharge facilities related to IPR elements of conceptual alternatives 18
Figure 3-3. Existing facilities related to conceptual alternatives 20
Figure 3-4. Alternative 1 elements 24
Figure 3-5. Alternative 1 purified water flow balance 25
Figure 3-6. Alternative 2 elements 26
Figure 3-7. Alternative 2 purified water flow balance 27
Figure 3-8. Alternative 3 elements 29
Figure 3-9. Alternative 3 purified water flow balance 30
Figure 3-10. Alternative 4 elements 32
Figure 3-11. Alternative 4 purified water flow balance 33
Figure 3-12. Alternative 5 elements 34
Figure 3-13. Alternative 5 purified water flow balance 35
Figure A-1. Palo Alto: groupings of potential NPR customers A-1
Figure A-2. Palo Alto: recommended NPR facilities A-2
Figure A-3. Mountain View: NPR expansion alternatives A-3
Figure A-4. Sunnyvale: NPR expansion and phasing A-5
Figure A-5. Cupertino (Cal Water/SJW): proposed Alignment T facilities A-6
Figure A-6. Santa Clara: actual and projected recycled water demand A-7
Figure A-7. San Jose Water: proposed recycled water alignments A-8
Figure A-8. Milpitas: proposed recycled water infrastructure A-9
Figure A-9. Gilroy: existing RWS and potential users A-10
Figure A-10. Gilroy: recommended NPR system expansion A-11
Figure A-11. Morgan Hill: potential recycled water users A-12
Figure B-1. NPR+ process flow diagram for Sunnyvale WPCP B-2

List of Tables

Table ES-1. Summary of Projected Long-Term NPR Demands by Partner Agency 2
Table ES-2. Pros and Cons of Conceptual Alternatives 4
Table ES-3. Preliminary Estimate of Purified Water Available for PR Alternatives 7
Table ES-4. Conceptual Alternative Scoring 8
Table 2-1. Summary of Projected Long-Term NPR Demands by Partner Agency 10
Table 3-1. Preliminary List of Project Elements 15
Table 3-2. Pros and Cons of All Alternatives 20
Table 3-3. Preliminary Estimate of Supply Available for Purified Water in 2035 22
Table 3-4. Capacities of Recharge Ponds and WTP to Potentially Receive Purified Water for PR 23
Table 3-5. Pros and Cons of Alternative 1 25
Table 3-6. Pros and Cons of Alternative 2 28
Table 3-7. Pros and Cons of Alternative 3 31
Table 3-8. Pros and Cons of Alternative 4 33
Table 3-9. Pros and Cons of Alternative 5 36
Table 3-10. Purified Water Available for PR Alternatives 36
Table 4-1. Objectives Considered When Developing Criteria 37
Table 4-2. Prioritization Criteria and Weighting 38
Table 5-1. Scale for Scoring Conceptual Alternatives 39
Table 5-2. Conceptual Alternatives' Scores 42
Table A-1. Comparison of Projected Long-Term NPR Demands in Mountain View A-4
Table A-2. Long-Term NPR Demands: Baseline Source vs. 2015 UWMP A-14
Table B-1. NPR+ Blending Requirements B-2

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List of Abbreviations

ADWF	average dry weather flow
AFY	acre-foot/feet per year
AWPF	advanced water purification facility
Cal Water	California Water Service Company
CIP	capital improvement program
County	Santa Clara County
DAC	disadvantaged community
DPR	direct potable reuse
DWR	Department of Water Resources
FSRWE	*Feasibility Study for Recycled Water Expansion*
GHG	greenhouse gas
GW	groundwater
GWR	groundwater recharge
IPR	indirect potable reuse
L	liter(s)
LGRP	Los Gatos Recharge Ponds
Master Plan	*Countywide Water Reuse Master Plan*
MF	microfiltration
mg/L	milligram(s) per liter
MG	million gallons
mgd	million gallons per day
MPU	*Master Plan Update*
N/A	not applicable
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NPR+	enhanced non-potable reuse
O&M	operations and maintenance
PA/MV	Palo Alto/Mountain View
PPG	Project Partner Group
PR	potable reuse
Reclamation	U.S. Bureau of Reclamation
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWF	regional wastewater facility
RWFE	*Recycled Water Feasibility Evaluation*
RWFP	*Recycled Water Facility Plan*
RWFS	*Recycled Water Feasibility Study*
RWMP	*Recycled Water Master Plan*
RWQCP	Regional Water Quality Control Plant
RWS	recycled water system
SBWR	South Bay Water Recycling
SCP	Silver Creek Pipeline
SCRWA	South County Regional Wastewater Authority
SJMWS	San José Municipal Water System
SJ/SC RWF	San José-Santa Clara Regional Wastewater Facility
SJW	San Jose Water[1]
SMP	*Strategic and Master Plan*
SVAWPC	Silicon Valley Advanced Water Purification Center
TDS	total dissolved solids
TM	technical memorandum
UWMP	urban water management plan
Valley Water	Santa Clara Valley Water District
WPCP	water pollution control plant
WSMP	*Water Supply Master Plan*
WTP	water treatment plant
WWTP	wastewater treatment plant

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[1] San Jose Water does not use an accent in its name, though City of San José does.

Executive Summary

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) to improve water supply reliability through water reuse for Santa Clara County (County). Valley Water is building on its partnerships with four non-potable reuse (NPR) systems in the county, referred to as Partner Agencies:

- Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS)
- Sunnyvale RWS
- South Bay Water Recycling (SBWR)
- South County Regional Water Authority (SCRWA)

The conceptual alternatives evaluation assesses the County's water reuse market, identifies conceptual project alternatives, and evaluates the alternatives through a prioritization and assessment methodology. The purpose of this deliverable is to select three alternatives to move forward for feasibility evaluation. This is intended as an interim deliverable; alternatives (also called "project elements and portfolios") will be refined as the project evolves.

Market Assessment

Among other objectives, the Master Plan aims to identify opportunities for potable reuse (PR) development and NPR expansion in the county, and the optimal split between PR and NPR. To identify, locate, and quantify potential future NPR demand in the County, Valley Water performed an NPR market assessment using 2035 projections from the water retailers' 2015 urban water management plans (UWMP). The one exception is the City of Morgan Hill (within the SCRWA service area), whose 2015 UWMP projected zero long-term NPR deliveries. Because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, Valley Water will evaluate NPR alternatives in this Technical Memorandum (TM). Thus, the following analysis uses Morgan Hill's conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

Demand projections by Partner Agency, as summarized in Table ES-1, provide a basis for developing conceptual alternatives to meet future demands. NPR demand projections do not fully capture potential allocations per contractual agreements. For example, the City of Palo Alto is contractually obligated to provide up to 3 million gallons per day (mgd) of recycled water to the City of Mountain View, but projected NPR demands are less than 3 mgd. This analysis assumes future NPR usage aligns with the projections shown in Table ES-1; however, some Partner Agencies are in the process of updating their projected NPR demands. If finalized in time, these revised projections will be incorporated into the Master Plan.

Use of contents on this sheet is subject to the limitations specified at the beginning of this document. Much of the information in this document has been superseded by more updated information included with later deliverables. This document should not be considered as a standalone document but as an interim component of the Countywide Water Reuse Master Plan.

Table ES-1. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	2035 NPR Demand, mgd (AFY)[a]	Current Contractual Obligation[b]
PA/MV RWS	City of Palo Alto City of Mountain View	2.5 (2,800)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	City of Sunnyvale California Water Service Company (Cal Water) (Cupertino) San Jose Water (Cupertino)	1.5 (1,700)	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	City of Santa Clara San José Municipal Water System (SJMWS) San Jose Water City of Milpitas	21.5 (24,100)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA	City of Gilroy City of Morgan Hill	3.3 (3,700) 2.6 (2,900)[c]	N/A
County Total		31.5 (35,200)	

a. Projected 2035 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Updated NPR demand projections from Partner Agencies will be incorporated into the Master Plan if/when available.

b. Projected NPR demands do not fully capture potential allocations per contractual agreements.

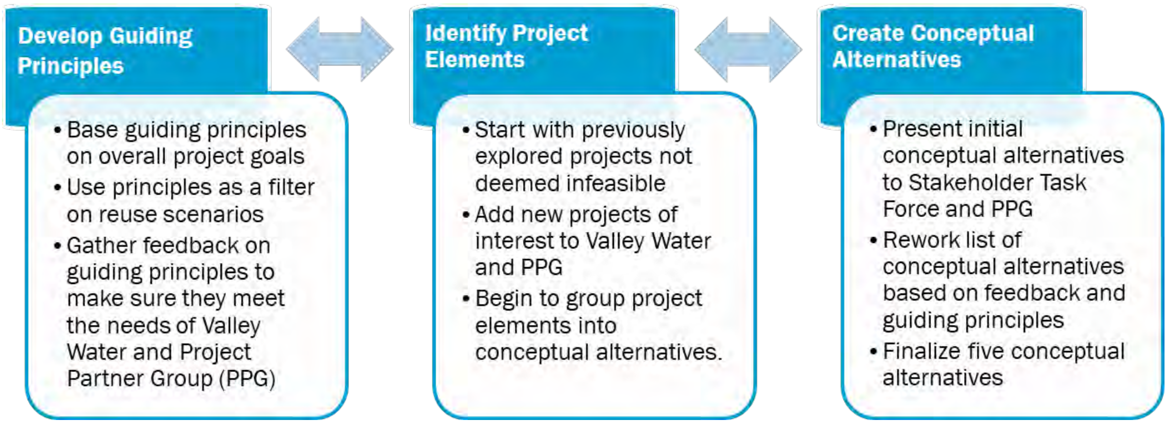
c. Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.

mgd = million gallons per day

AFY = acre-foot/feet per year

Conceptual Alternatives Development

Figure ES-1 illustrates the process used to develop conceptual alternatives for the Master Plan.



Develop Guiding Principles

- Base guiding principles on overall project goals
- Use principles as a filter on reuse scenarios
- Gather feedback on guiding principles to make sure they meet the needs of Valley Water and Project Partner Group (PPG)

Identify Project Elements

- Start with previously explored projects not deemed infeasible
- Add new projects of interest to Valley Water and PPG
- Begin to group project elements into conceptual alternatives.

Create Conceptual Alternatives

- Present initial conceptual alternatives to Stakeholder Task Force and PPG
- Rework list of conceptual alternatives based on feedback and guiding principles
- Finalize five conceptual alternatives

Figure ES-1. Process used to develop conceptual alternatives

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Development of conceptual alternatives was guided by the following principles:

- Consider previously explored projects (not previously deemed infeasible, unless circumstances have changed) and new projects
- Reflect a mix of NPR and PR projects
- Aim to develop at least 24,000 AFY of PR supply by 2028 to meet the County's water supply demands (per Valley Water's 2019 Water Supply Master Plan [WSMP] 2040)
- Expand countywide NPR and/or PR using source water from each of the Partner Agencies
- Leverage existing infrastructure where possible

The alternatives include a mix of potential project elements, including some previously proposed projects (from various recycled water master plans [RWMP]) and some new elements. Based on Partner Agency input, Valley Water developed the following five conceptual alternatives for evaluation:

- **Alternative 1:** indirect potable reuse (IPR) (from San José-Santa Clara [SJ/SC]) and expanded NPR
- **Alternative 2:** IPR (from Palo Alto/Sunnyvale) and expanded NPR
- **Alternative 3:** IPR (from Palo Alto and Morgan Hill) and expanded NPR
- **Alternative 4:** IPR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR
- **Alternative 5:** IPR (from Morgan Hill), direct potable reuse (DPR) (from SJ/SC), and expanded NPR

Each alternative has a unique set of pros and cons, which were considered during the alternatives ranking and selection process. Table ES-2 lists the pros and cons common to all five conceptual alternatives, as well as those for each alternative.

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Table ES-2. Pros and Cons of Conceptual Alternatives

Alternative	Pros	Cons
All Alternatives	• Reduced discharge to San Francisco Bay / Monterey Bay • Enhanced NPR across entire North County (PA/MV RWS, Sunnyvale RWS, and SBWR) • Interties (especially bi-directional) increase reliability and operational flexibility • Decreased dependence on imported water • Local supplies offsetting imports could reduce greenhouse gas (GHG) overall	• Reverse osmosis (RO) concentrate management challenges • Interties will require new agreements • Environmental impacts of construction
Alternative 1	• Increased reliability throughout county from enhanced NPR interties • Augments groundwater (GW) supply from single facility • Separate advanced water purification facilities (AWPF) allow for streamlining implementation • Known treatment technologies	• Capital and operations and maintenance (O&M) costs related to 3 new AWPFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill enhanced NPR distribution system • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Agreements required for multiple interties • Silver Creek Pipeline (SCP) agreement may expire
Alternative 2	• Increased reliability throughout county from enhanced NPR interties • Augments GW supply from regional AWPF (served by the Palo Alto Regional Water Quality Control Plant [RWQCP] and Sunnyvale Water Pollution Control Plant [WPCP]), which has greater feed reliability than an AWPF served by the Sunnyvale WPCP alone • Known treatment technologies	• Capital and O&M costs related to 2 new APWFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill enhanced NPR distribution system • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Requires two transmission pipelines between PA/MV and Sunnyvale for AWPF influent and enhanced NPR • Agreements required for multiple interties • SCP agreement may expire • Limited agency experience in IPR via groundwater recharge (GWR)
Alternative 3	• Increased reliability for Sunnyvale and SBWR • Augments GW in North and South counties, each from a single facility • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Separate AWPFs allow for streamlining implementation • Known treatment technologies	• Capital and O&M costs related to 3 new APWFs (26,900 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Greater distance between Palo Alto and Los Gatos Recharge Ponds (LGRP) than between SJ/SC and Sunnyvale facilities • Less water to LGRP than Alternatives 1 and 2 • Larger AWPF in Palo Alto requires more land than other alternatives • PA/MV system remains separate, limiting NPR expansion in PA/MV • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR

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Table ES-2. Pros and Cons of Conceptual Alternatives

Alternative	Pros	Cons
Alternative 4	• Increased reliability for PA/MV and Sunnyvale from enhanced NPR intertie • Augments GW supply from regional AWPF (fed by the Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF fed by the Sunnyvale WPCP alone • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Known treatment technologies	• Capital and O&M costs related to 3 new AWPF (36,700 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • SBWR remains separate, limiting NPR expansion in San José • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR
Alternative 5	• Increased reliability in North County from enhanced NPR interties • Greater reliability for potable water than the other alternatives • Augments GW from single facility and agency experienced in GWR • Separate AWPFs streamline implementation • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP	• Capital and O&M costs related to 4 new AWPFs (39,600 AFY combined purified water capacity, including Morgan Hill) and 2 interties • Costly improvements for DPR and purified water production capacity and monitoring (highest of all alternatives) • DPR regulations are not yet established • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Unknown additional technologies for achieving DPR level of treatment • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations

Note: This is not an exhaustive list. Some criteria, such as cost, greenhouse gas emissions, or other, may appear as a pro or a con, depending on the alternative.

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The conceptual alternatives are not defined at the level of detail needed to estimate utilization, which depends on a number of factors, including:

- Local groundwater conditions
- Water system operations (e.g., flow balancing)
- Recovery rates and reverse osmosis concentrate (ROC) management options
- Local water rights and source priorities
- Water demands

Estimated utilization rates, and how the rates may vary temporally, will be considered in the feasible portfolios evaluation.

The supply available for purified water in 2035 was calculated based on projected NPR demands, losses, and environmental flow requirements, as well as the amount of effluent needed for enhanced NPR (also known as NPR+). NPR+ involves blending purified water (full-advanced treatment or equivalent water quality) with Title 22 recycled water for total dissolved solids (TDS) reduction, targeting a maximum TDS of 500 milligrams per liter (mg/L) in the NPR+ system (see Attachment B for more details). Valley Water is assuming full advanced treatment—including associated recovery rates—at all advanced water purification facilities listed in Table ES-2; however, Valley Water is also exploring the feasibility of alternative treatment trains, which may result in increased recovery rates.

In this analysis, it was assumed that remaining effluent (i.e., plant influent minus NPR demands, losses, and environmental flows) would be available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Available PR supply was calculated using assumed recovery rates for advanced treatment. A PR flow balance was completed by allocating the available purified water to each recharge pond or water treatment plant (WTP) that would receive PR in each conceptual alternative. Table ES-3 compares estimated purified water flows among alternatives, rounded to the nearest 100 AFY. These estimates are preliminary; source water flow projections may be refined as new information (e.g., updated NPR demand projections) becomes available.

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Table ES-3. Preliminary Estimate of Purified Water Available for PR Alternatives

Supply Source	Source Water Available for PR, Considering Treatment Losses[a] (AFY)	Purified Water Provided for PR (AFY)[b]				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Palo Alto RWQCP	14,100[c]	0	14,000	14,100	14,000	0
Sunnyvale WPCP	10,300[c]	0	10,000	0	10,000	0
SJ/SC Regional Wastewater Facility (RWF) • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	71,800[e] 74,300[e]	24,000 N/A	0 N/A	N/A 0	N/A 0	N/A 26,900
SCRWA Service Area • Potential Future Morgan Hill AWPF and Satellite Plant	2,800	0	0	2,800[f]	2,800[f]	2,800[f]
County total • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	99,000 101,500	24,000 24,000	24,000 24,000	17,000[g] 17,000[g]	26,800 26,800	29,700 29,700
PR locations		LGRP	LGRP	LGRP, South County recharge ponds	LGRP, South County recharge ponds	Penitencia WTP, South County recharge ponds

a. *Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Treatment losses account for advanced treatment recovery rates.*

b. *Purified water provided is limited to recharge capacity or treatment capacity of receiving facility.*

c. *Based on high estimates of future losses and potential environmental flows.*

d. *Alternatives 1 and 2 include Morgan Hill NPR+. Alternatives 3, 4, and 5 do not.*

e. *Per the assumptions in the Baseline Analysis TM, no potential environmental flows were considered for SJ/SC RWF.*

f. *Delivered to recharge ponds in South County; exact location TBD.*

g. *Difference due to rounding.*

N/A = not applicable.

Process and Outcomes of Alternatives Assessment

Valley Water developed criteria and weighting factors to evaluate the conceptual alternatives. Criteria were initially developed based on objectives of the Master Plan and those common to U.S. Bureau of Reclamation and Department of Water Resources funding opportunities, and then refined based on Partner Agencies' input. Each alternative was awarded a score between 1 (unable to satisfy requirements) and 5 (fully satisfies requirements) for each criterion. The criteria, weighting, and scores for each alternative are shown in Table ES-4.

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Table ES-4. Conceptual Alternative Scoring

Criterion	Weighting	Conceptual Alternative Scores				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Economics	25%	3.0	3.0	2.0	3.0	1.0
Groundwater management and countywide (regional) supply reliability	25%	3.0	3.0	2.0	4.0	5.0
Environmental impacts/benefits and sustainability	20%	4.0	4.0	3.0	4.0	2.0
Ease of implementation and permitting/regulatory considerations	15%	5.0	4.0	2.0	3.0	1.0
Engineering feasibility	15%	4.0	4.0	3.0	3.0	1.0
Total		3.7	3.5	2.4	3.5	2.2

Based on the results of the scoring process, the top three alternatives include:

- **Alternative 1:** IPR (from SJ/SC) and expanded NPR
- **Alternative 2:** IPR (from Palo Alto/Sunnyvale) and expanded NPR
- **Alternative 4:** IPR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR

These alternatives will be refined and further evaluated in the feasible portfolios evaluation.

Other Considerations and Next Steps

The three alternatives selected to move forward to feasible portfolios evaluation will be developed to a preliminary (10 percent) design and further evaluated using detailed prioritization criteria and other factors, such as economics, environmental impacts/benefits, governance considerations, and risk.

Valley Water will continue to facilitate meetings and workshops with the PPG, Executive Leadership Group, Stakeholder Task Force, and the Valley Water Board of Directors' Recycled Water Committee to discuss and refine the Draft Master Plan Report. The Final Master Plan Report will be developed in close coordination with these partners and stakeholders.

Section 1: Introduction

The Santa Clara Valley Water District (Valley Water) initiated the Countywide Water Reuse Master Plan (Master Plan) to improve water supply reliability through water reuse for Santa Clara County (County). Valley Water is building on its partnerships with four non-potable reuse (NPR) systems in the county, referred to as Partner Agencies, to integrate existing plans and infrastructure. The Partner Agencies include:

- Palo Alto/Mountain View (PA/MV) Recycled Water System (RWS)
- Sunnyvale RWS
- South Bay Water Recycling (SBWR)
- South County Regional Wastewater Authority (SCRWA)

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The Master Plan will identify the volume of water available for potential potable reuse (PR) development and NPR expansion, the optimal allocation between PR and NPR, options for system integration, recommendations for building on NPR projects and creating new PR projects, and proposals for governance model alternatives, including roles and responsibilities. In parallel, Valley Water is developing an updated Water Supply Master Plan (WSMP) that describes its strategy for providing a reliable and sustainable water supply in a cost-effective manner.

The conceptual alternatives evaluation is one of several interim deliverables leading up to the final Master Plan. Building on several earlier technical memoranda (TM)—the Project Definition, Roles, and Responsibilities TM, Regulatory Framework TM, and Baseline Analysis TM—this Conceptual Alternatives TM assesses the County's water reuse market, identifies conceptual project alternatives, and evaluates the alternatives through a prioritization and assessment methodology. The purpose of this deliverable is to select three alternatives that will move forward for feasibility evaluation.

Section 2: Market Assessment

Among other objectives, the Master Plan aims to identify opportunities for PR development and NPR expansion in the county and the optimal split between PR and NPR. To identify, locate, and quantify potential future NPR demand in the county, Valley Water developed a comprehensive NPR market assessment (Attachment A). The market assessment builds on existing planning documents, informs the optimal NPR/PR split, and provides a basis for developing conceptual alternatives to meet future demands.

2.1 Long-term NPR Demands

In preparing the NPR market assessment, Valley Water reviewed the water retailers' most recent recycled water planning documents available and 2015 urban water management plan (UWMP) demand projections, developed by water suppliers in coordination with recycled water producers. The 2015 UWMPs generally contain the most recent demand projections and were used to predict future demands in the Baseline Analysis TM; therefore, they remain the basis for long-term demand projections in this TM.[2] Because UWMPs typically do not explain the assumptions underlying demand projections, it is helpful to review other planning documents for comparison and, where long-term demands differ significantly, further investigate. Details on the retailers' recycled water studies, including target customer areas, recommended pipeline alignments, and differences from the 2015 UWMPs are included in Attachment A. Despite differences for individual cities, total countywide demand projections from the previous sources and 2015 UWMPs are within 2.5 percent of each other. NPR demand projections may be updated as the Master Plan progresses if new information becomes available from the Partner Agencies.

Table 2-1 summarizes total, long-term NPR demands within the Partner Agencies' service areas. These demand projections do not fully capture potential allocations per contractual agreements. For example, the City of Palo Alto is contractually obligated to provide up to 3 million gallons per day (mgd) of recycled water to the City of Mountain View, but projected NPR demands are less than 3 mgd. This analysis assumes future NPR usage aligns with the projections shown in Table 2-1; governance considerations and potential new

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[2] One exception is the City of Morgan Hill (within the SCRWA service area), whose 2015 UWMP projected zero long-term NPR deliveries; however, because an NPR project in Morgan Hill may be feasible in the context of a larger, countywide plan, this TM re-evaluates an NPR system using Morgan Hill's conceptual buildout demands from the 2015 South County Recycled Water Master Plan Update.

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agreements will be further considered when evaluating feasibility. The boundaries of the Partner Agencies' service areas are shown on Figure 2-1.

Table 2-1. Summary of Projected Long-Term NPR Demands by Partner Agency

Partner Agency	Water Retailers	Long-term NPR Demand, mgd (AFY)[a]	Current Contractual Obligation[b]
PA/MV RWS	• City of Palo Alto • City of Mountain View	2.5 (2,800)	Mountain View has the right to receive up to 3 mgd of peak flow
Sunnyvale RWS	• City of Sunnyvale • Cal Water (Cupertino) • San Jose Water (Cupertino)	1.5 (1,700)	Valley Water can receive 595 AFY for distribution within Sunnyvale and at least 500 AFY for distribution outside Sunnyvale's city limits
SBWR	• City of Santa Clara • San José Municipal Water System (SJMWS) • San Jose Water • City of Milpitas	21.5 (24,100)	Valley Water has the right to at least 5 mgd from the Silver Creek Pipeline
SCRWA	• City of Gilroy • City of Morgan Hill	3.3 (3,700) 2.6 (2,900)[c]	N/A
County total		31.5 (35,200)	

a. Projected 2035 NPR demands from 2015 UWMPs within the retail water service areas, rounded to the nearest 100 AFY. For the City of Morgan Hill, NPR demand is equal to the conceptual buildout demand identified in the 2015 South County Recycled Water Master Plan Update. Long-term demands assume that any existing NPR is estimated into the future year UWMP demands, if applicable.

b. Projected NPR demands do not fully capture potential allocations per contractual agreements.

c. Morgan Hill's conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update.

AFY = acre-foot/feet per year

N/A = not applicable

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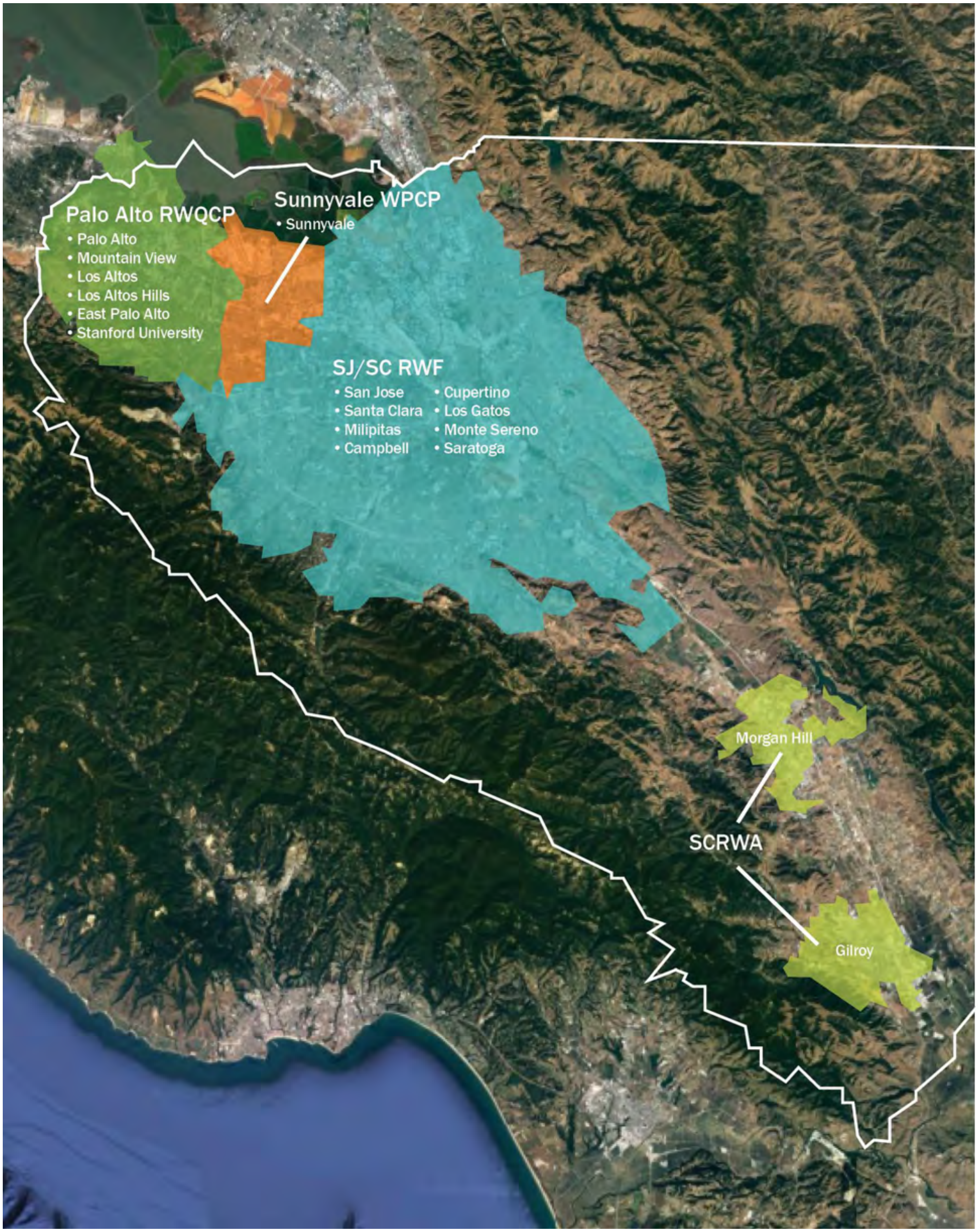

Figure 2-1. Partner Agencies' service area boundaries

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2.2 Identifying the Optimal NPR/PR Split

As discussed in the Baseline Analysis TM, the first step in the preliminary evaluation of the optimal NPR/PR split was to identify flows potentially available for additional reuse. These flows were calculated by subtracting the following flow streams from estimated wastewater treatment plant (WWTP) influent:

- 2015 UWMP NPR demand estimates for years 2025 and 2035. These estimates include recycled water usage at the Palo Alto Regional Water Quality Control Plant (RWQCP) and SCRWA WWTP.
- Environmental flows and other losses, such as evaporation. These losses were obtained from public documents or those made available by Partner Agencies.

The NPR market assessment (Attachment A) was completed to inform potential additional NPR opportunities and revise the NPR demand projections, if needed. As discussed in Section 2.1, the results indicate that the market would not support additional NPR beyond the 2015 UWMP estimates; therefore, the 2015 UWMP NPR demand projections were carried forward, except for the City of Morgan Hill, for which conceptual buildout demands per the 2015 South County Recycled Water Master Plan Update were used. NPR demand projections may be updated going forward as new information becomes available from the Partner Agencies.

As described further in Section 4, input regarding potential conceptual alternatives, evaluation criteria, and important project considerations was solicited from project partners and stakeholders during the development of conceptual alternatives. During this process, project partners confirmed the assumption that their projected NPR demands should be kept intact and not made available for other uses. Although the remaining flow could be potentially available as source water for PR, its production may be limited by the capacity of existing treatment and distribution facilities and groundwater recharge (GWR) basins.

These assumptions and considerations, along with the updated market assessment and partner input, have guided the preferred NPR/PR split, as illustrated on Figure 2-2. Based on this process, NPR demands were maintained at the UWMP estimates, and PR solutions were the focus of the remaining effluent (minus any potential requirements for discharge or blending). Enhanced NPR (NPR+), which involves blending purified water with Title 22 recycled water for improved water quality, was also incorporated to allow for interties and improved countywide NPR reliability.

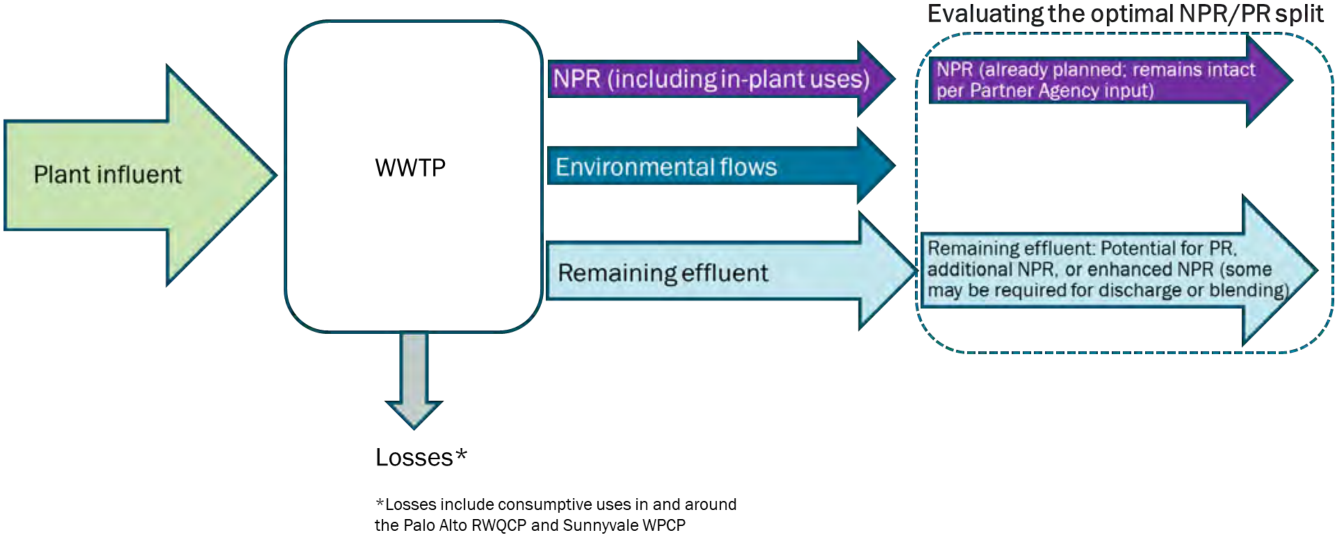
Evaluating the optimal NPR/PR split
Plant influent
WWTP
NPR (including in-plant uses)
Environmental flows
Remaining effluent
NPR (already planned; remains intact per Partner Agency input)
Remaining effluent: Potential for PR, additional NPR, or enhanced NPR (some may be required for discharge or blending)
Losses*
*Losses include consumptive uses in and around the Palo Alto RWQCP and Sunnyvale WPCP

Figure 2-2. Flows considered for NPR/PR split

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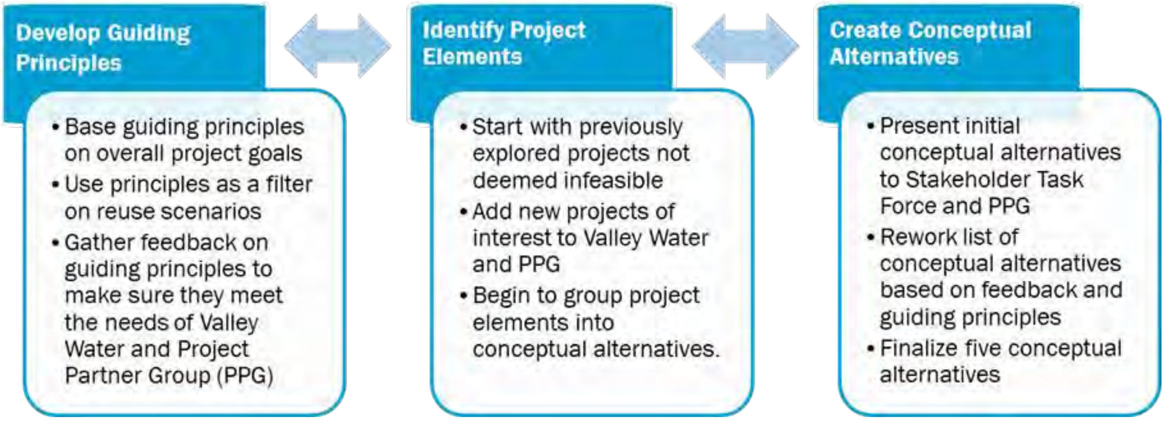
Potential project elements and flow balances are discussed in Section 3. The optimal NPR/PR split may be reevaluated, as needed, throughout development of feasible portfolios.

Section 3: Conceptual Alternatives Development

The process used to develop conceptual alternatives for the Master Plan is illustrated on Figure 3-1 and further described in this section. The conceptual alternatives build on existing planning studies completed by various utilities across the county.



Develop Guiding Principles

- Base guiding principles on overall project goals
- Use principles as a filter on reuse scenarios
- Gather feedback on guiding principles to make sure they meet the needs of Valley Water and Project Partner Group (PPG)

Identify Project Elements

- Start with previously explored projects not deemed infeasible
- Add new projects of interest to Valley Water and PPG
- Begin to group project elements into conceptual alternatives.

Create Conceptual Alternatives

- Present initial conceptual alternatives to Stakeholder Task Force and PPG
- Rework list of conceptual alternatives based on feedback and guiding principles
- Finalize five conceptual alternatives

Figure 3-1. Process used to develop conceptual alternatives

3.1 Process

This section describes the process for developing conceptual alternatives, including the guiding principles applied and basis used.

3.1.1 Guiding Principles

To guide development of alternatives for consideration in this Master Plan, Valley Water identified several guiding principles to provide an early filter on the vast range of possible reuse scenarios. Each alternative must meet the following tenets; these guiding principles support the overall project goal and objectives.

- Consider previously explored projects (not previously deemed infeasible, unless circumstances have changed) and new projects
- Reflect a mix of NPR and PR projects
- Aim to develop at least 24,000 AFY (approximately 21.4 mgd) of PR supply by 2028 to meet the County’s water supply demands (per Valley Water’s 2019 WSMP 2040)
- Expand countywide reuse (NPR and/or PR) using source water from each of the Partner Agencies
- Leverage existing infrastructure where possible

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3.1.2 Basis for Conceptual Alternatives

Previously explored projects from various recycled water master plans (RWMP) (referred to in Attachment A: Market Assessment) were reviewed to identify the elements that could be combined to align with guiding principles.

During a PPG meeting held June 21, 2018, Valley Water and its Partner Agencies reviewed and discussed an initial set of potential conceptual alternatives. The initial alternatives reflected various thematic combinations of individual projects (elements of each alternative) and were built on a foundation of previously identified projects. Valley Water also identified some new potential projects, including options for developing reuse in Morgan Hill.

Valley Water configured five initial alternatives based on location, proximity, and end use objectives (i.e., NPR and/or PR). To explore the full range of options, two of the five initial alternatives focused on (1) solely expanding NPR and (2) solely developing PR (with continued implementation of currently planned NPR projects). The PPG collectively preferred some mix of both NPR and PR elements. The conceptual alternatives were developed from a mix of identified potential project elements, described in Section 3.2. Based on PPG input, Valley Water developed five conceptual alternatives for screening, as further described in Section 3.3.

3.2 Potential Project Elements

Valley Water identified 17 potential project elements for consideration, as summarized in Table 3-1. Each element is included in at least one conceptual alternative. Project elements and alternatives will be further refined as part of the feasible portfolios evaluation.

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Table 3-1. Preliminary List of Project Elements

No.	Potential Partner(s)	Element	Delivered Water Type	Alternative					Description
				1	2	3	4	5	
1	PA/MV	Palo Alto AWPF	NPR+ or Indirect Potable Reuse (IPR) (via GWR)	✓	✓	✓	✓	✓	Includes a new advanced water purification facility (AWPF) in Palo Alto that is supplied by the RWQCP. Purified water would be sent directly to the Los Gatos Recharge Ponds (LGRP) and/or blended with recycled water for NPR+. Palo Alto is currently planning a 2.25-mgd AWPF (capable of producing a maximum annual volume of ~2,500 AFY) for NPR+. Options involving an AWPF in Palo Alto for IPR would require a larger or separate facility to accommodate both NPR+ and IPR.
2	PA/MV	PA/MV NPR system expansion	NPR+	✓	✓	✓	✓	✓	Includes pumping, storage, and distribution associated with extending service to Stanford Research Park (Palo Alto Phase 3) and the National Aeronautics and Space Administration (NASA)/Whisman School Park alignments, as described in Attachment A. Palo Alto is planning a 2.25-mgd AWPF (capable of producing a maximum annual volume of ~2,500 AFY) to blend purified water with recycled water to supply NPR+ to customers in PA/MV.
3	PA/MV	Palo Alto RWQCP-Sunnyvale AWPF: pipeline	Effluent		✓		✓		Includes wastewater effluent distribution facilities (pumps and pipelines) connecting Palo Alto RWQCP and Sunnyvale Water Pollution Control Plant (WPCP) wastewater effluent to a new, regional AWPF located in either Palo Alto or Sunnyvale.
4	PA/MV	Palo Alto AWPF to LGRP: pipeline	IPR (via GWR)			✓			Includes purified water distribution facilities (pumps and pipeline) connecting a new AWPF in Palo Alto to the LGRP.
5	PA/MV and Sunnyvale	PA/MV-Sunnyvale intertie	NPR+	✓				✓	Includes pipeline crossing Mountain View and Sunnyvale border connecting PA/MV and Sunnyvale NPR systems. Implementation would require similar water quality, most likely NPR+.
6	Sunnyvale and PA/MV	Sunnyvale AWPF or Regional AWPF	NPR+ or IPR	✓	✓	✓	✓	✓	Includes a new AWPF supplied by the Sunnyvale WPCP. Purified water would be blended with recycled water produced at Sunnyvale WPCP. When combined with element #8, AWPF is also supplied by the Palo Alto RWQCP and could be located in either Sunnyvale or Palo Alto.
7	Sunnyvale	Sunnyvale NPR system expansion	NPR+	✓	✓	✓	✓	✓	Involves customer retrofits along recently completed Wolfe Road Main and other infill sites. As mentioned in Attachment A, future expansion could include new pipelines in Sunnyvale as detailed in the Sunnyvale Feasibility Study for Recycled Water Expansion (FSRWE), pending direction from Valley Water regarding countywide recycled water planning.
8	Sunnyvale and PA/MV	Regional AWPF to LGRP: pipeline	IPR		✓		✓		Includes distribution facilities (pumps and pipeline) to convey purified water from a regional AWPF (element #6) to the LGRP.
9	Sunnyvale and SBWR	Sunnyvale-SBWR intertie	NPR+	✓	✓	✓		✓	Includes pipeline crossing Sunnyvale and Santa Clara border connecting Sunnyvale and SBWR systems. Implementation would require NPR+ in Sunnyvale prior to intertie.
10	SBWR	San José/Santa Clara (SJ/SC) AWPF	IPR (via GWR) or Direct Potable Recharge (DPR)	✓				✓	Includes a new AWPF fed by the SJ/SC Regional Wastewater Facility (SJ/SC RWF). Purified water would be delivered to the LGRP (IPR) or Penitencia WTP (DPR, via raw water augmentation), so this element is linked with a distribution project below.

Table 3-1. Preliminary List of Project Elements

No.	Potential Partner(s)	Element	Delivered Water Type	Alternative 1	2	3	4	5	Description
11	SBWR	SBWR NPR system expansion	NPR+	✓	✓	✓	✓	✓	Includes infill projects in North San José and Santa Clara (including data center cooling and dual plumbing). San Jose Water (SJW) plans to sign up additional customers along existing alignments and construct multiple extensions, while Milpitas seeks to extend the system to the planned Milpitas Transit Area and adjacent golf courses. Any treatment (e.g., Silicon Valley Advanced Water Purification Center [SVAWPC] expansion), pumping, and storage requirements are also included.
12	SBWR	SJ/SC AWPF to LGRP: pipeline	IPR (via GWR)	✓					Includes purified water distribution facilities (pumps and pipeline) connecting the new AWPF to the LGRP.
13	SBWR	SJ/SC AWPF to Penitencia WTP: pipeline	IPR (via GWR)/DPR (via raw water augmentation)	✓				✓	Includes purified water distribution facilities (pumps and pipeline) blending purified water from the SJ/SC AWPF with raw water at Penitencia WTP.
14	SBWR and SCRWA	SBWR-Morgan Hill intertie and Morgan Hill NPR+ system	NPR+	✓	✓				Involves importing recycled water from SBWR to a new NPR+ distribution system in Morgan Hill, including pumps, storage, and distribution system pipelines.
15	SCRWA	Morgan Hill satellite plant and AWPF	IPR (via GWR)			✓	✓	✓	Includes new treatment facilities (satellite plant and AWPF) that would treat wastewater from the sewer trunk line between Morgan Hill and Gilroy and produce purified water for delivery to recharge ponds in South County.
16	SCRWA	Morgan Hill AWPF to South County recharge ponds: pipeline	IPR (via GWR)			✓	✓	✓	Includes purified water distribution facilities (pumps and pipeline) connecting the new AWPF to recharge ponds in South County.
17	SCRWA	Gilroy NPR system expansion	NPR	✓	✓	✓	✓	✓	Includes treatment, pumping, storage, and distribution improvements to improve reliability and extend service within a 10-mile radius of the SCRWA facility.

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Potential NPR elements include expanding the existing NPR system, adding advanced treatment for enhancing recycled water quality (NPR+)[3] and interconnecting distribution networks. NPR+ involves blending purified water (full advanced treatment or equivalent water quality) with Title 22 recycled water for total dissolved solids (TDS) reduction, targeting a maximum TDS of 500 mg/L in the NPR+ system (see Attachment B for more details). 500 mg/L is the drinking water secondary maximum contaminant level for TDS and represents a threshold for protecting groundwater quality when, for example, recycled water is used for irrigation and excess irrigation water percolates into the ground. This higher-quality water would then be delivered to NPR customers using the existing distribution system. Valley Water is assuming full advanced treatment—including associated recovery rates—at all advanced water purification facilities listed below; however, Valley Water is also exploring the feasibility of alternative treatment trains, which may result in increased recovery rates.

Some elements are interdependent. For example, Sunnyvale must reduce TDS prior to interconnecting with the SBWR system, so any alternative proposing a Sunnyvale-SBWR intertie must also include an AWPF in Sunnyvale. Palo Alto is currently planning a 2.25-mgd capacity AWPF (capable of producing a maximum annual volume of approximately 2,500 AFY) for NPR+ (Final Advanced Water Purification System Feasibility, May 2017); thus, an intertie between Sunnyvale and Palo Alto would also require an AWPF in Sunnyvale.

To remain consistent with previous Master Plan work products, this TM uses 2035 recycled water (i.e., NPR) demand projections from 2015 UWMPs, as described in Section 2; however, UWMPs do not necessarily explain the basis for demand projections, which can differ significantly from recycled water plans. For the purpose of this document, future NPR expansion is assumed to occur at locations generally identified within Partner Agencies' recycled water plans up to the annual projections identified in corresponding 2015 UWMPs.

Project elements consider previously explored projects (i.e., not previously deemed infeasible, unless circumstances have changed) and new projects. While most project elements summarized in Table 3-1 have been deemed feasible, one exception is Morgan Hill, whose 2015 UWMP projected zero long-term NPR supply. Although Morgan Hill's 2016 Recycled Water Feasibility Evaluation (RWFE) did not recommend developing an NPR system, an NPR project may be more feasible in the context of a larger, countywide plan. Therefore, Valley Water is further exploring project elements in Morgan Hill as part of this Master Plan, including a connection with SBWR.[4] In addition, Morgan Hill is currently evaluating the potential for a satellite plant to feed an AWPF for GWR, which represents a changed condition from the 2015 South County RWMP Master Plan Update (MPU) and warrants consideration in the countywide context. A satellite plant would divert wastewater from the collection system in Morgan Hill that would otherwise flow to the SCRWA WWTP. Operating scenarios have not been fully developed at this conceptual level, such as operation only during wet or dry years. Ideally a satellite plant, in coordination with equalization and storage, that feeds an AWPF would be sized in a way to allow for continuous AWPF operation. Intermittent operation of an AWPF is not recommended and could negatively impact operation and maintenance.

Because the satellite plant would reduce future planned flows to the SCRWA WWTP, potential impacts to existing plants and flow projections for expanding the SCRWA WWTP must be considered. In addition, an AWPF in Morgan Hill would produce a reverse osmosis (RO) concentrate stream, which may be challenging to manage. A common approach for satellite plants is to discharge brine back to the sewer; however, returning the brine to SCRWA may not be a feasible option because of salt concentration limits identified in Valley Water's 2014 and 2015 Salt and Nutrient Management plans. Potential reverse osmosis concentrate (ROC) management options have not been fully developed at the conceptual level, but will be further explored as part of the feasible portfolios evaluation.

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[3] Referred to as "Enhanced Recycled Water" in Valley Water's Reverse Osmosis Concentrate Management Plan.

[4] The Silver Creek Agreement with the City of San José entitles Valley Water to a minimum of 5 mgd of recycled water for Valley Water to distribute and/or sell to whomever it wishes, including outside the City of San José tributary agencies

Potential IPR elements using GWR in the northern portion of the county involve source water from Palo Alto, Sunnyvale, and the (SJ/SC RWF and the production and conveyance of purified water to the LGRP. In the SBWR Strategic and Master Plan (SMP), various PR project alternatives were evaluated for both near-term and long-term implementation. The SBWR SMP identified LGRP as a key component for long-term PR implementation because the recharge ponds are located off-stream and have the largest potential recharge capacity (24,000 AFY) if managed flows are re-operated. Considering existing and projected stream diversion and carry-over imported water operations management, Valley Water determined that this is the only recharge system accessible to North County with the recharge capacity to sustain a major GW replenishment initiative in the Santa Clara Subbasin. As a result, this document has based IPR implementation on using LGRP for GWR.

Potential IPR (via GWR) elements in South County are limited to those involving recharge within the South County area. Although IPR options are described in the 2015 South County Recycled Water Master Plan Update, further study would be needed to determine South County GWR locations. GW subbasins in the county, along with existing recycled water facilities, are shown on Figure 3-2.

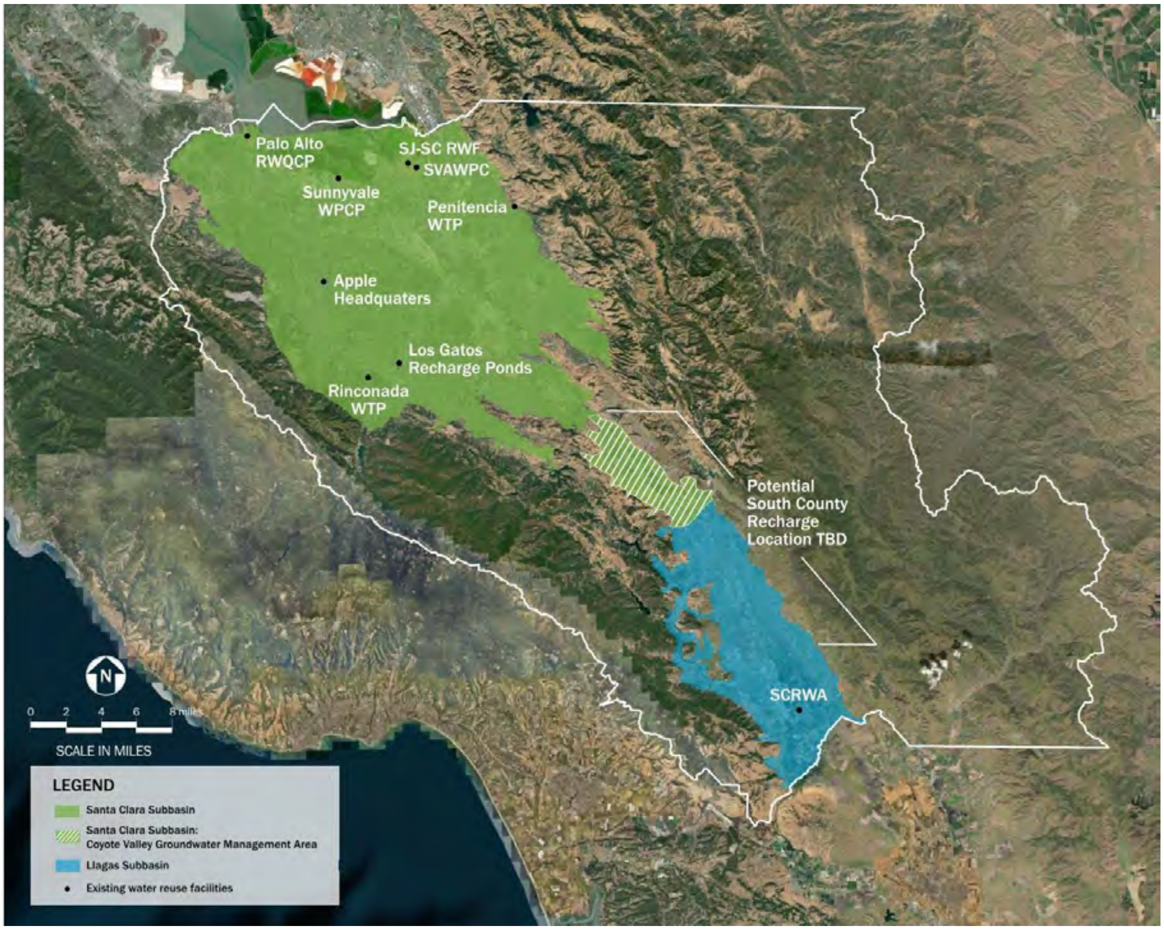

Figure 3-2. GW subbasins and recharge facilities related to IPR elements of conceptual alternatives

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Potential DPR elements in the conceptual alternatives involve raw water augmentation. Though California does not yet have a regulatory framework for raw water augmentation, the state is developing such regulations by 2023. The DPR scenario considered in the conceptual alternatives involves constructing a new AWPF near the SJ/SC RWF and a new conveyance pipe to deliver purified water to the Central Pipeline. From the Central Pipeline, purified water would be blended with raw (untreated) water from the South Bay Aqueduct before flowing to either the Penitencia Water Treatment Plant (WTP) or Rinconada WTP for conventional treatment. Raw water augmentation was not considered in South County as it would not be as directly beneficial as IPR via GWR. Though treated water augmentation was not considered in the conceptual alternatives, future treated water augmentation opportunities will be explored as part of the feasibility evaluation.

3.2.1 Intertie Opportunities

Interties that connect existing recycled water distribution systems will increase NPR system flexibility, reliability, and potentially the quantity of source water available from a specific producer. By sizing interties and constructing storage tanks to allow the receiving agency to supplement its NPR demand with the use of imported recycled water, “local” effluent becomes available for other purposes. Using recycled water from multiple sources can also improve diurnal supply reliability, particularly for systems that have higher peak hour NPR demands. This more diversified supply portfolio frees Partner Agencies to explore NPR expansion opportunities while also maximizing the utilization rate of countywide reuse efforts.

Though no demands or quantities of recycled water flowing through interties are shown in the following sections, this will be detailed as part of subsequent efforts of this Master Plan. Specifically, the feasible portfolios analysis will detail the use, location, size, and quantity of recycled water transported by interties. As a default scenario, the interties will allow for the transport of recycled water among the Partner Agencies such that Valley Water can plan PR and NPR elements detailed herein with a level of confidence that they can supply that quantity of water during most types of years. Where required, adding storage tanks, pump stations, pressure sustaining valves, and pressure zones to convey recycled water between distribution systems while maintaining pressure within each system will be evaluated.

Interties between NPR systems were also planned assuming that all interconnected systems would have similar TDS concentrations. Thus, if one NPR distribution system had NPR+, any system interconnected to it would also have NPR+ in any evaluated alternative.

3.3 Conceptual Alternatives

Valley Water combined the 17 potential project elements introduced in Section 3.2 into five conceptual alternatives. Elements common to all five alternatives are listed below:

- **Elements 1 and 6:** Constructing new AWPFs in Palo Alto and Sunnyvale.
- **Elements 2, 7, 11, and 17:** Expanding existing NPR systems (PA/MV, Sunnyvale, SBWR, and SCRWA) to deliver enough recycled water to meet the 2035 recycled water demands outlined in each water retailer’s 2015 UWMP. Further, elements 2, 7, and 11 include improving recycled water quality in North County NPR systems (PA/MV RWS, Sunnyvale RWS, and SBWR) for NPR+.

In the following subsections, each alternative is described further in terms of major project elements, a flow balance, and pros and cons relative to other alternatives. Each is illustrated as a graphic depicting proposed project elements on a countywide scale. The graphics show existing facilities as gray. New advanced treatment facilities are color-coded based on function; purple AWPFs augment NPR systems, and blue AWPFs supply IPR and DPR projects. Figure 3-3 reflects the existing/baseline conditions.

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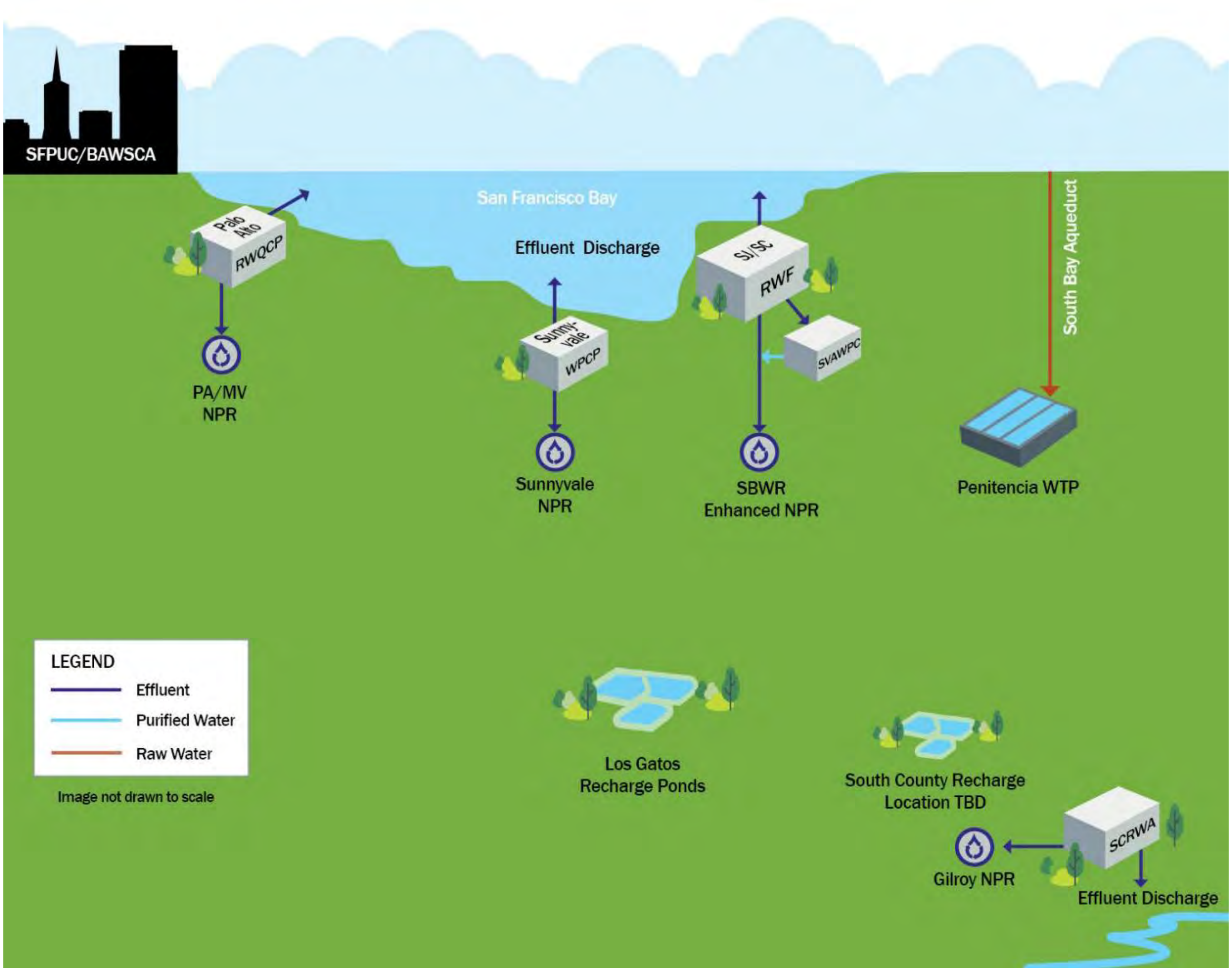

Figure 3-3. Existing facilities related to conceptual alternatives.

Pros and cons that apply to all alternatives are summarized in Table 3-2. ROC management options for the alternatives will be further detailed in the ROC Management Plan, a parallel but separate effort from this Master Plan. Similarly, the benefits of reduced nutrient loading to San Francisco Bay and Monterey Bay are addressed in other studies and not evaluated in this TM.

Table 3-2. Pros and Cons of All Alternatives

Pros	Cons
• Reduced discharge to San Francisco Bay/ Monterey Bay • NPR+ across entire North County (PA/MV RWS, Sunnyvale RWS, and SBWR) • Interties (especially bi-directional) increase reliability and operational flexibility • Decreased dependence on imported water • Local supplies offsetting imports could reduce GHG overall	• RO concentrate management challenging • Interties will require new agreements • Environmental impacts of construction

Note: This is not an exhaustive list. Some criteria, such as cost, greenhouse (GHG) gas emissions, or other, may appear as a pro or a con, depending on the alternative.

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The conceptual alternatives are not defined at the level of detail needed to estimate utilization, which depends on a number of factors, including:

- Local groundwater conditions
- Water system operations (e.g., flow balancing)
- Recovery rates and ROC management options
- Local water rights and source priorities
- Water demands

Actual utilization rates and how the rates may vary temporally will be considered in the feasible portfolios evaluation.

Flow balances are based on the projected 2035 effluent availability analysis presented in the Baseline Analysis TM, which accounts for losses, potential environmental flows, and NPR demand. However, where new AWPFs are considered for NPR+, recovery rates of microfiltration (MF) and RO increase the amount of flow required to meet NPR demands. Though SBWR already delivers NPR+, the available effluent estimated in the baseline analysis did not factor in blending for SJ/SC RWF for simplicity. Per Valley Water's ROC Management Plan Basis of Design TM, MF and RO are assumed to be 93 and 85 percent efficient, respectively. In other words, while 1.00 unit of effluent could produce 1.00 unit of tertiary recycled water, it takes approximately 1.27 units (1/0.93/0.85) of effluent to produce 1.00 unit of purified water.

All four Partner Agencies have an NPR+ multiplier of approximately 1.1, as described further in Attachment B. That is, for every 1,000 AFY of NPR demand, approximately 1,100 AFY of effluent is needed to produce 1,000 AFY of NPR+. Flow balances presented in the following subsections account for improved NPR water quality at the Palo Alto RWQCP, Sunnyvale WPCP, and SJ/SC RWF. Since NPR+ was not considered in the 2015 South County Recycled Water MPU, the alternatives do not contemplate changing the water quality of NPR produced at the SCRWA WWTP, so an adjustment is not necessary for that flow.

The volume of available purified water was calculated by applying advanced treatment (MF/RO) recovery rates to available effluent (influent less NPR demand, losses, and potential environmental flows). These values, rounded to the nearest 100 AFY, are provided in Table 3-3 for 2035. A range of estimated losses is shown for PA/MV and Sunnyvale to reflect varying assumptions. To be conservative, the higher losses (resulting in less available purified water) were carried forward in the conceptual alternatives analysis. Flow assumptions may be further refined as more recent data and/or projections become available.

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Table 3-3. Preliminary Estimate of Supply Available for Purified Water in 2035

Partner Agency	Available Influent (AFY)[a]	Influent Required to Produce and Meet NPR+ Demands (AFY)[b]	Losses/Potential Environmental Flows (AFY)	Available Effluent/AWPF Feed (AFY)[c]	Available Purified Water (AFY)
Palo Alto RWQCP	24,700	3,100	1,500–3,700[d]	17,900–20,100	14,100–15,900
Sunnyvale WPCP	19,400	1,900	1,600–4,500[e]	13,000–15,900	10,300–12,600
SJ/SC RWF					
• With Morgan Hill NPR+	120,200	29,400[f]	0	90,800	71,800
• Without Morgan Hill NPR+	120,200	26,300	0	93,900	74,300
SCRWA Service Area • Potential Morgan Hill AWPF and Satellite Plant	3,600[g]	N/A	0	3,600	2,800
Countywide Total[h]	167,900	31,300-34,400	3,000-8,200	125,300-133,600	99,000-105,600

a. *Estimated based on 2015-2017 actuals and projected rate of increase from previous planning studies, as further described in the Baseline Analysis TM.*

b. *NPR demands do not necessarily include contractual obligations. For this analysis, it was assumed that NPR demands will increase per 2015 UWMP projections, and any remaining effluent (after accounting for losses, potential environmental flows, and the supply required to produce and meet NPR+ demands) would be available for AWPF feed. New agreements, however, may be needed to access this full amount for countywide use.*

c. *Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements.*

d. *Flow to Renzel Marsh, ranging from 1 mgd (~1,100 AFY; current amount reflected in National Pollutant Discharge Elimination System [NPDES] permit) to 3 mgd (~3,400 AFY; future potential expansion), along with an estimated 0.3 mgd (~300 AFY) loss of effluent used for in-plant processes (per Palo Alto's 2015 UWMP).*

e. *Low end of range reflects actual evaporation from 2015–16, which was 1.4 mgd on average (1,600 AFY); high end of range assumes 4 mgd (4,500 AFY) of evaporative and other losses.*

f. *The additional influent requirement of 3,100 AFY is the product of the NPR demand identified in the 2015 South County RWMP Update (2,900 AFY for conceptual buildout in Morgan Hill) and the SJ/SC RWF "NPR+ multiplier."*

g. *Assumes 3.2 mgd (3,600 AFY) will be diverted from the existing trunk sewer to produce purified water in Morgan Hill. No project elements were identified that involved SCRWA WWTP as the AWPF feed source.*

h. *Difference due to rounding.*

Some project elements that interconnect systems may affect the volume of supply available for other purposes. For example, if SBWR supplies Morgan Hill's new NPR+ system, more SJ/SC RWF effluent would be needed to produce additional recycled water and purified water for blending. The SCRWA WWTP and proposed Morgan Hill satellite plant are similarly related, as any wastewater diverted in Morgan Hill would reduce available influent to the SCRWA WWTP. Based on the baseline analysis, an average of 3.2 mgd (approximately 3,600 AFY) of effluent is available from the SCRWA WWTP during 2035. According to the 2010 Relief Trunk Capacity Allocation study developed by the City of Morgan Hill, future average dry weather flow (ADWF) in the trunk sewer from Morgan Hill was estimated at 5.2 mgd (approximately 5,800 AFY), so there is sufficient flow to divert the entire available volume (3.2 mgd, or 3,600 AFY) to produce purified water in Morgan Hill. Using the aforementioned advanced treatment recovery rates, this translates to approximately 2,800 AFY of purified water. When NPR demand in the Gilroy area exceeds available effluent from the SCRWA WWTP, this deficit could be supplied by groundwater wells. The satellite plant element was chosen in lieu of adding an AWPF at SCRWA because it eliminates the need to convey flow to a SCRWA AWPF for treatment and then back to Morgan Hill for distribution.

The preliminary PR flow balance was completed by allocating the available purified water to each recharge pond or WTP that would receive PR per the conceptual alternative. Table 3-4 summarizes the capacities for the LGRP, South County recharge ponds (using Church Recharge Ponds as a proxy), and Penitencia WTP. For the recharge ponds, capacities represent the maximum annual volume the ponds can accept. Penitencia WTP capacity is based on delivery to a new 3-million-gallon (MG) storage tank near the treatment plant. Flow balance figures for each alternative focus on the allocation of purified water for NPR+ and PR, because the assumed NPR and losses/environmental flows are the same across all alternatives. The color scheme is similar to the figures showing major elements of each alternative: gray facilities are existing, purple facilities produce purified water for NPR+, and blue facilities supply purified water for PR.

Table 3-4. Capacities of Recharge Ponds and WTP to Potentially Receive Purified Water for PR

Receiving Facility	Reuse Type	Annual Capacity (AFY)	Source
Los Gatos Recharge Ponds	IPR (via GWR)	24,000	Valley Water Expedited Purified Water Program Plan
Penitencia WTP	DPR (via raw water augmentation)	26,900[a]	Valley Water Expedited Purified Water Program Plan
South County recharge ponds[b]	IPR (via GWR)	7,300	Morgan Hill 2016 RWFE

a. *Based on 24 mgd (26,900 AFY) delivery to new 3-MG purified water tank near Penitencia WTP.*

b. *Specific location in South County to be decided in feasible alternatives. The annual capacity of Church Recharge Ponds is currently referenced as a proxy.*

3.3.1 Alternative 1: IPR via GWR (from SJ/SC) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 1.

3.3.1.1 Major Project Elements

Alternative 1 combines expanded and interconnected NPR+ systems with IPR supply from the SJ/SC RWF. New AWPFs would be located in Palo Alto (as currently planned) and Sunnyvale for NPR+ (elements 1 and 6), allowing for connection to the SBWR system (elements 5 and 9) and NPR+ deliveries (elements 2, 7, and 11). In addition, a new NPR system in Morgan Hill would be supplied by SBWR (element 14), so NPR+ systems would be interconnected among all three North County systems and Morgan Hill in South County. An expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality.

A new AWPF would also be constructed in San José to produce purified water from SJ/SC RWF effluent (element 10), along with new distribution facilities to transport purified water from the new AWPF to the LGRP (element 12). Figure 3-4 illustrates the major elements of Alternative 1.

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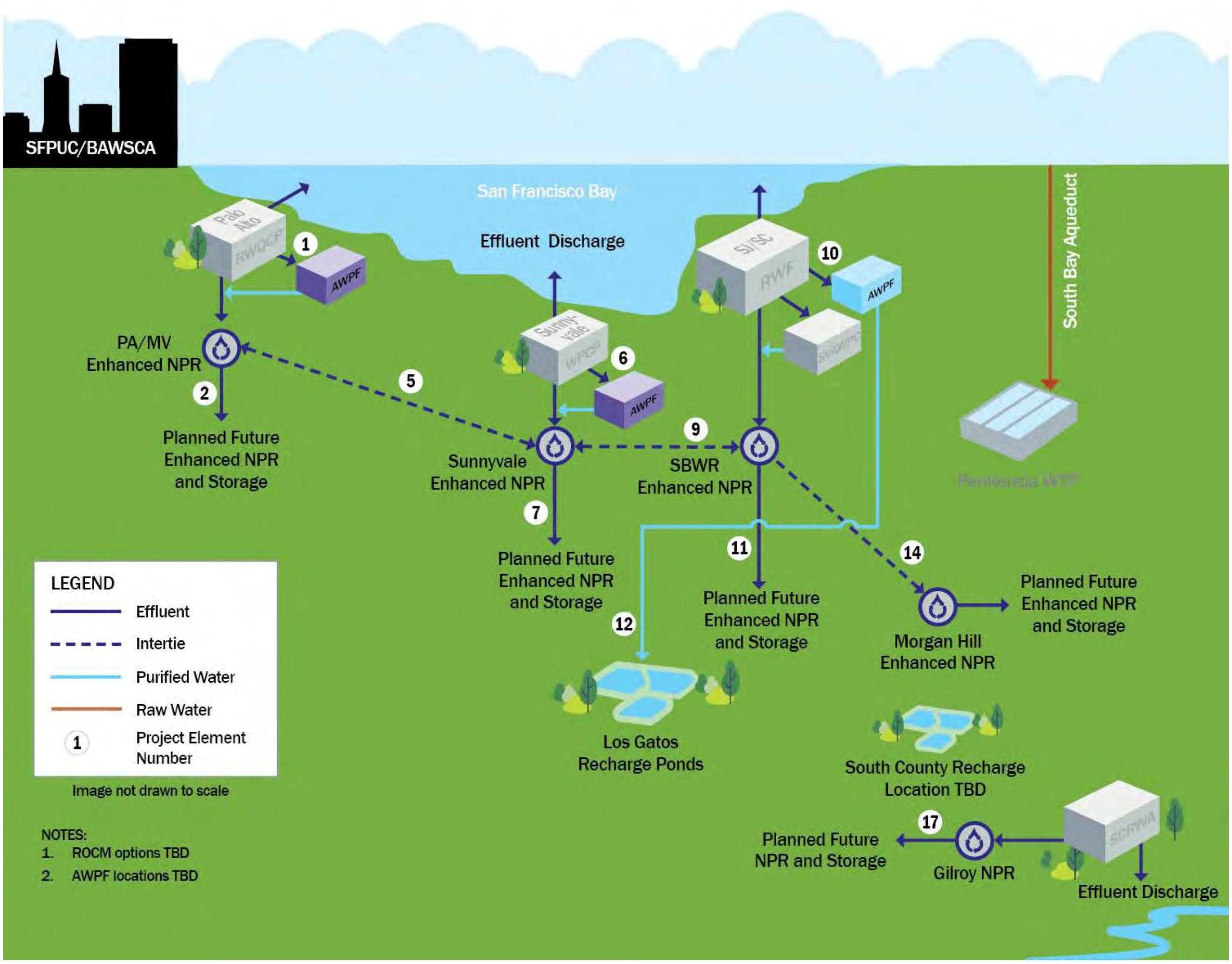

Figure 3-4. Alternative 1 elements

3.3.1.2 Flow Balance

The SJ/SC facilities (Silicon Valley Advanced Water Purification Center [SVAWPC] and new AWPF) would be capable of providing sufficient volume to supply both the LGRP and Morgan Hill's new NPR+ system. After accounting for Morgan Hill NPR+ demands, available effluent from the SJ/SC RWF translates to approximately 71,800 AFY of available purified water. With 24,000 AFY going to the LGRP, approximately 47,800 AFY remains available for system reliability and flexibility, including future water reuse expansion considerations. Figure 3-5 illustrates the purified water flows for Alternative 1.

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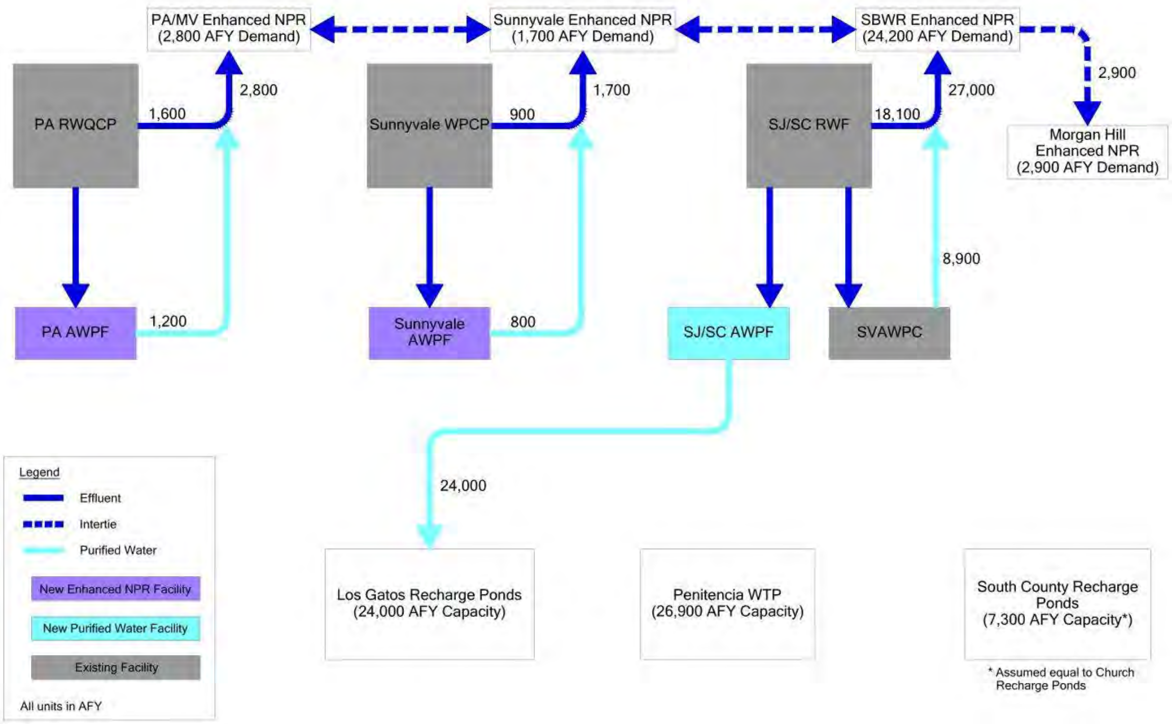

Figure 3-5. Alternative 1 purified water flow balance

3.3.1.3 Pros and Cons

Alternative 1 features extensive improvements (one AWPF for IPR via GWR, two AWPFs for NPR+, and North County NPR+ interties), which increase supply reliability and operational flexibility and enhance NPR water quality. In addition, having separate AWPFs allows implementation to proceed independently without having to wait for permitting or agreements from potential partners.

Connecting a new Morgan Hill NPR system to SBWR would utilize the Silver Creek Pipeline (SCP), which extends from Silver Creek Valley Road to the Metcalf Energy Center at the southern tip of the SBWR system. Valley Water cost-shared in oversizing the SCP in exchange for the right to use a minimum of 5 mgd (5,600 AFY) from it. This use agreement between Valley Water and the City of San José expires in 2027. Securing long-term supply to Morgan Hill would require a new or updated agreement. This is consistent with other interties, which will also require agreements. Lastly, with almost 100 feet of elevation gain, pumping recycled water from SBWR to Morgan Hill will require significant amounts of energy. Table 3-5 highlights the pros and cons of Alternative 1 relative to other conceptual alternatives.

Table 3-5. Pros and Cons of Alternative 1

Pros	Cons
• Increased reliability throughout county from NPR+ interties • Augments GW supply from single facility and agency experienced in GWR • Separate AWPFs allow for streamlining implementation • Known treatment technologies	• Capital and operation and maintenance (O&M) costs related to 3 new AWPFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill NPR+ distribution system • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Agreements required for multiple interties • SCP agreement may expire

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3.3.2 Alternative 2: IPR via GWR (from Palo Alto/Sunnyvale) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 2.

3.3.2.1 Major Project Elements

Alternative 2 features expanded and interconnected NPR+ systems in North County, similar to Alternative 1 except IPR supply would come from a Sunnyvale AWPF instead of one located in San José. A new, regional AWPF in Sunnyvale would take effluent from both the Palo Alto RWQCP and the Sunnyvale WPCP (elements 3 and 6) and supply purified water to the LGRP (element 8). In addition, the AWPF would allow for NPR+ deliveries in Sunnyvale (element 7) and the SBWR service area (element 11). A new AWPF in Palo Alto for NPR+ deliveries (elements 1 and 2) would allow the North County NPR+ systems to be interconnected (elements 5 and 9).

South County elements (14 and 17) are identical to Alternative 1. Figure 3-6 illustrates the major elements of Alternative 2.

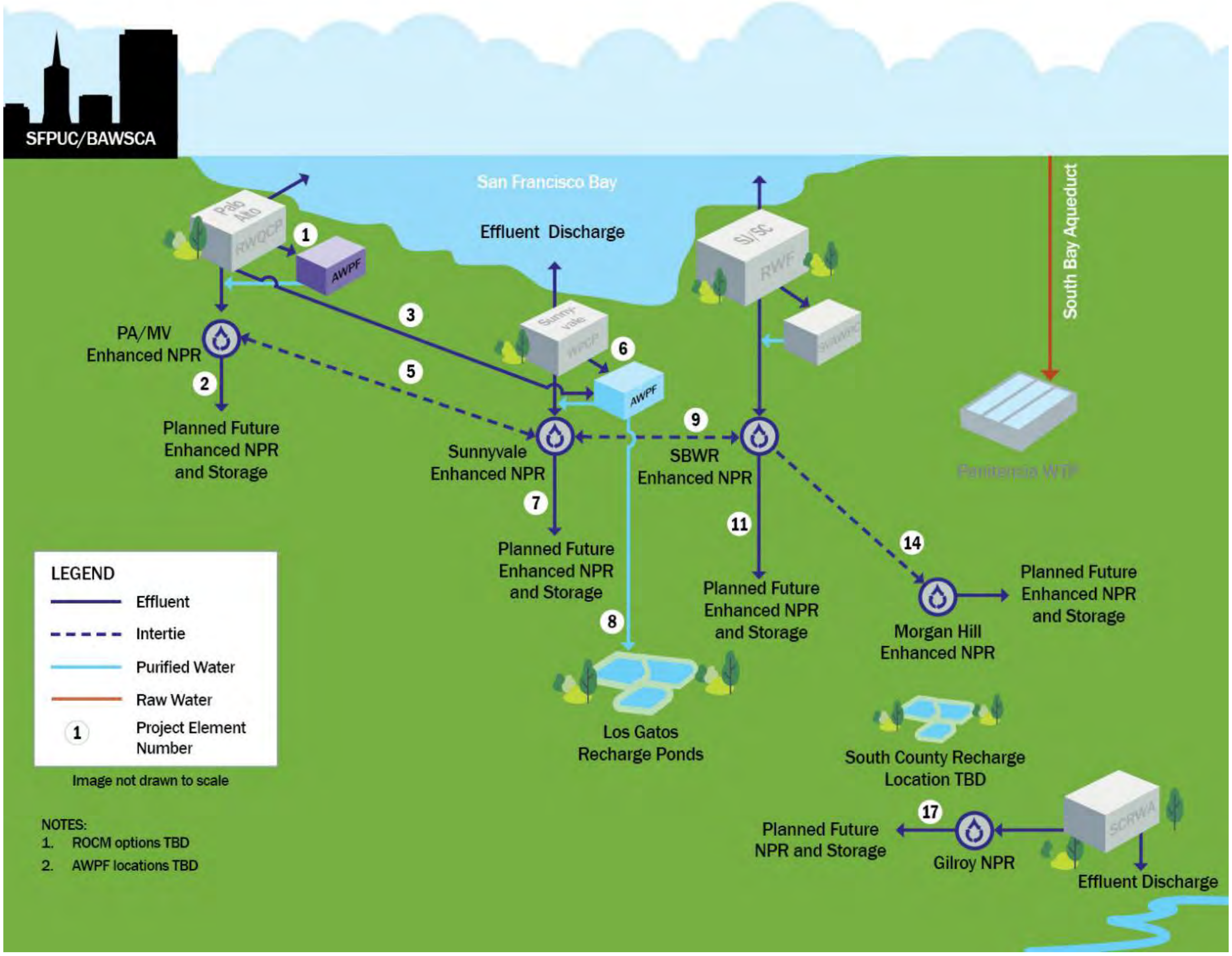

Figure 3-6. Alternative 2 elements

3.3.2.2 Flow Balance

Based on long-term projections, approximately 14,100 AFY of purified water would be available from the Palo Alto RWQCP, and the Sunnyvale WPCP could add approximately 10,300 AFY, for a total of 24,400 AFY. While this is just above the LGRP capacity of 24,000 AFY, the surplus was assumed to be negligible. See Figure 3-7 for a schematic of purified water flows.

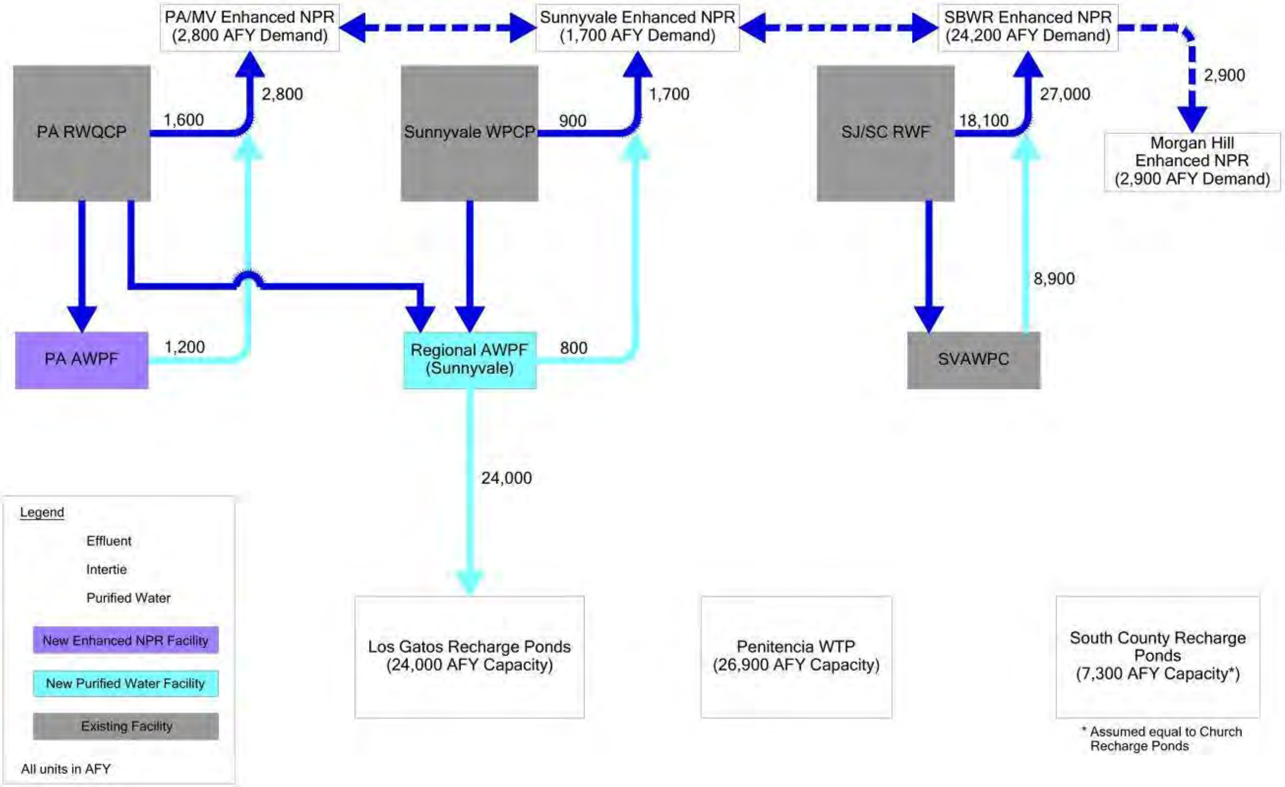
PA/MV Enhanced NPR (2,800 AFY Demand)
Sunnyvale Enhanced NPR (1,700 AFY Demand)
SBWR Enhanced NPR (24,200 AFY Demand)
2,900
Morgan Hill Enhanced NPR (2,900 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
18,100
27,000
8,900
PA AWPF
1,200
Regional AWPF (Sunnyvale)
800
SVAWPC
24,000
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-7. Alternative 2 purified water flow balance

3.3.2.3 Pros and Cons

By sending Palo Alto effluent to Sunnyvale for advanced treatment, permitting becomes more complex, as the regional AWPF in Sunnyvale would receive effluent from two sources. In addition, the City of Sunnyvale has relatively limited experience with IPR via GWR. On the other hand, taking effluent from a second Partner Agency would improve AWPF feed reliability. NPR+ reliability would also improve as a result of interties throughout North County.

Because Alternative 2 also proposes supplying Morgan Hill's NPR system via an intertie with SBWR, the same SCP challenge introduced in Alternative 1 would apply. Table 3-6 highlights the pros and cons of Alternative 2 relative to other conceptual alternatives.

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Table 3-6. Pros and Cons of Alternative 2	
Pros	Cons
• Increased reliability throughout county from NPR+ interties • Augments GW supply from regional AWPF (served by Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF served by Sunnyvale WPCP alone • Known treatment technologies	• Capital and O&M costs related to 2 new APWFs (34,900 AFY combined purified water capacity), 3 interties, and new Morgan Hill NPR+ distribution system • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • Significant pumping and pipe requirements for SBWR-Morgan Hill connection • Requires two separate transmission pipelines between PA/MV and Sunnyvale for AWPF influent and NPR+ • Agreements required for multiple interties • SCP agreement may expire • Limited agency experience in PR

3.3.3 Alternative 3: IPR via GWR (from Palo Alto and Morgan Hill) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 3.

3.3.3.1 Major Project Elements

Alternative 3 shifts the IPR supply from the Palo Alto RWQCP, which would feed a new AWPF in Palo Alto (element 1). Purified water would be delivered to the NPR+ system for blending (element 2) and the LGRP via a new pipeline (element 4). In contrast to Alternatives 1 and 2, the PA/MV NPR+ system would remain separate from Sunnyvale. A new AWPF in Sunnyvale (element 6) would improve NPR water quality, allowing for connection to SBWR (element 9) and expansion of both systems (elements 7 and 11).

Instead of an NPR+ system in Morgan Hill, Alternative 3 favors IPR via GWR in South County. New treatment and purification facilities would divert wastewater on its way to the SCRWA WWTP (element 15) for treatment and delivery to the selected recharge location in South County (element 16). As in Alternatives 1 and 2, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-8 illustrates the major elements of Alternative 3.

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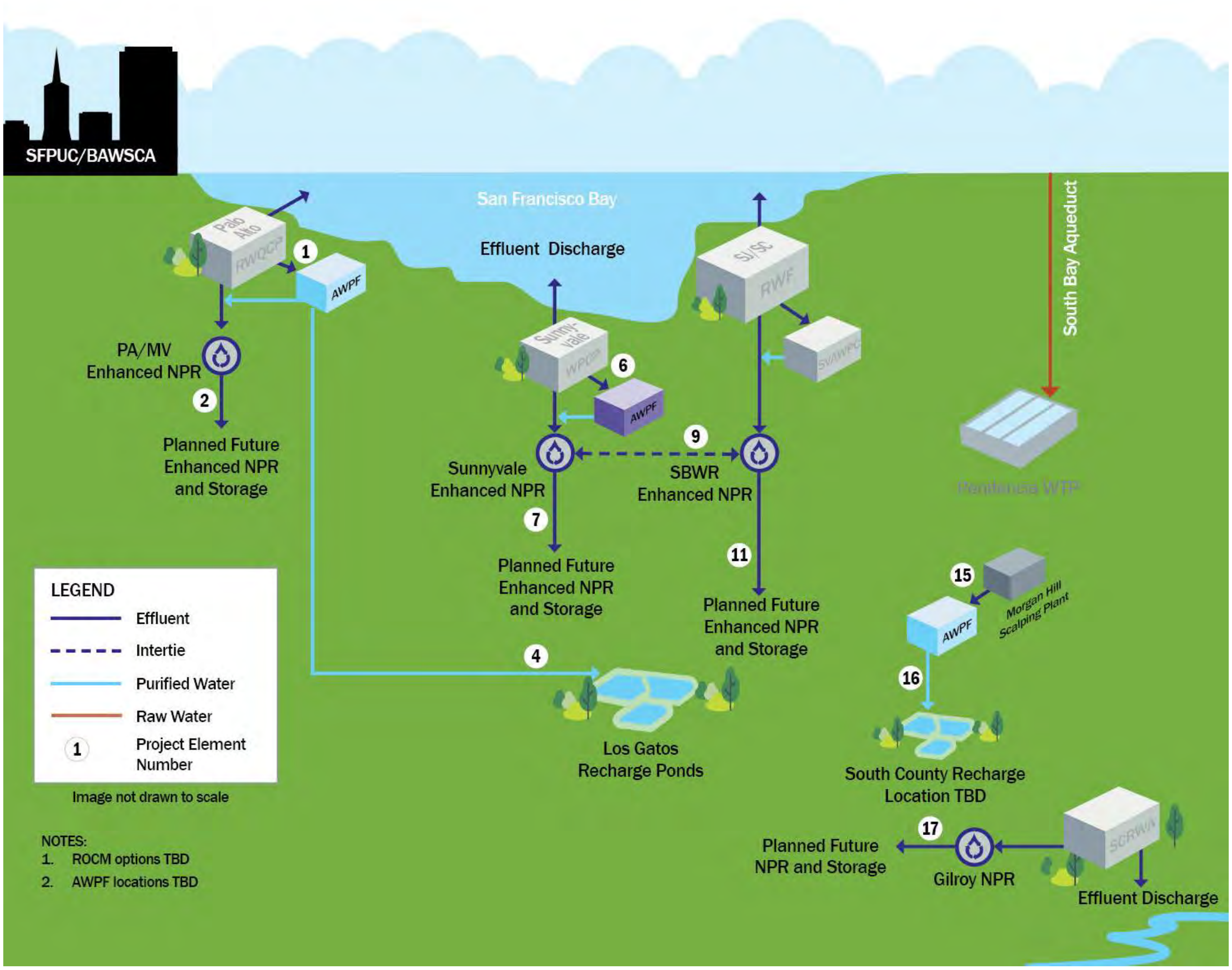

Figure 3-8. Alternative 3 elements

3.3.3.2 Flow Balance

With only approximately 14,100 AFY in available purified water, the Palo Alto RWQCP (and AWPF) cannot produce sufficient volume to meet the LGRP recharge capacity (24,000 AFY). Similarly, diverting and treating wastewater in Morgan Hill yields a modest amount (approximately 2,800 AFY). These elements are shown on Figure 3-9.

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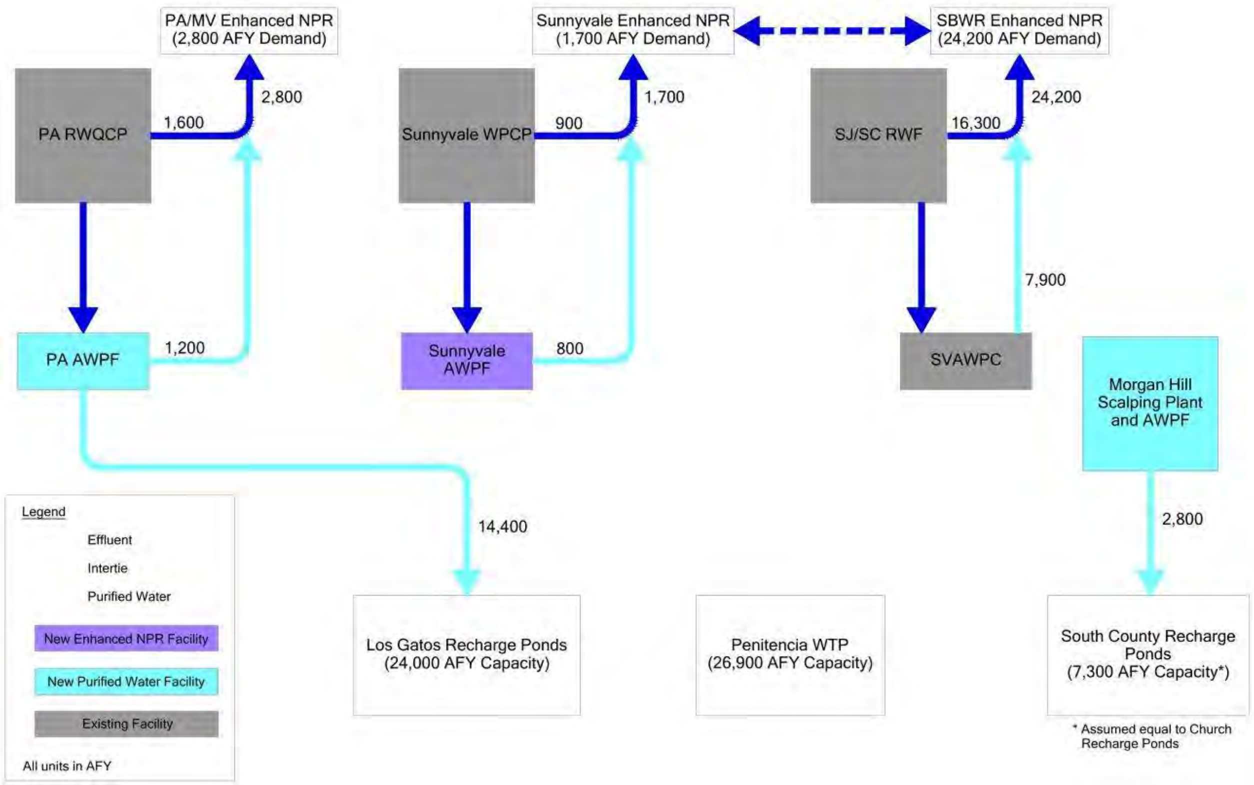
PA/MV Enhanced NPR (2,800 AFY Demand)
Sunnyvale Enhanced NPR (1,700 AFY Demand)
SBWR Enhanced NPR (24,200 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
16,300
24,200
7,900
PA AWPF
1,200
Sunnyvale AWPF
800
SVAWPC
Morgan Hill Scalping Plant and AWPF
14,400
2,800
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-9. Alternative 3 purified water flow balance

3.3.3.3 Pros and Cons

While Alternative 3 improves reliability across the Sunnyvale and SBWR systems, the PA/MV NPR system remains separate. With LGRP supply from Palo Alto, supplies are limited. Palo Alto would not be able to produce enough purified water to meet LGRP capacity, even if some of the flow was not reserved for NPR blending. At the same time, Palo Alto is farther from the LGRP than SJ/SC and Sunnyvale facilities, so conveyance for this alternative would cost more in comparison. Lastly, it is assumed that this alternative would require a larger AWPF in Palo Alto than the currently planned 2.25-mgd facility. Given the high cost of land in the area, this is a significant economic impact.

In South County, reduced flows to the SCRWA WWTP could have multiple effects, and the net impact remains unclear. While a new trunk sewer between Morgan Hill and the SCRWA WWTP could be delayed or possibly downsized, other capital improvements may be required. Odor and clogging issues in the collection system could arise if wastewater velocities are too low to scour the pipes and re-suspend solids. Further, biological processes at the WWTP could be compromised by changes in influent wastewater composition. According to the City of Morgan Hill’s 2016 RWFE, intermittent sludge wasting at the satellite plant could hinder biological treatment at the WWTP to the point that solids processing would be required at the WWTP, increasing capital and operational costs. Sludge loading and reduced flow to the WWTP could also create compliance issues. Table 3-7 highlights the pros and cons of Alternative 3 relative to other conceptual alternatives.

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Table 3-7. Pros and Cons of Alternative 3

Pros	Cons
Increased reliability for Sunnyvale and SBWR Augments GW in North and South Counties, each from a single facility Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP Separate AWPFs allow for streamlining implementation Known treatment technologies	Capital and O&M costs related to 3 new APWFs (26,900 AFY combined purified water capacity, including Morgan Hill) and 1 intertie Greater distance between Palo Alto and LGRP than SJ/SC and Sunnyvale facilities Less water to LGRP than Alternatives 1 and 2 Larger AWPF in Palo Alto requires more land than other alternatives PA/MV system remains separate, limiting NPR expansion in PA/MV Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated Diverting flow during higher demand periods could require supplemental water supply (e.g., well) Reduced/altered flow to SCRWA WWTP could impact operations Limited agency experience in IPR via GWR

3.3.4 Alternative 4: IPR via GWR (from Palo Alto/Sunnyvale and Morgan Hill) and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 4.

3.3.4.1 Major Project Elements

Alternative 4 favors IPR via GWR over system interties. A new AWPF in Palo Alto would produce purified water for blending (elements 1 and 2), while a regional AWPF in Sunnyvale would take effluent from both the RWQCP and WPCP for NPR blending and delivery to the LGRP (elements 3, 6, 7, and 8). The PA/MV and Sunnyvale NPR+ systems would be connected (element 5), but SBWR would remain separate (element 11). As in Alternative 3, Morgan Hill would divert and treat wastewater before purifying effluent for GWR (elements 15 and 16). As in Alternatives 1, 2, and 3, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-10 illustrates the major elements of Alternative 4.

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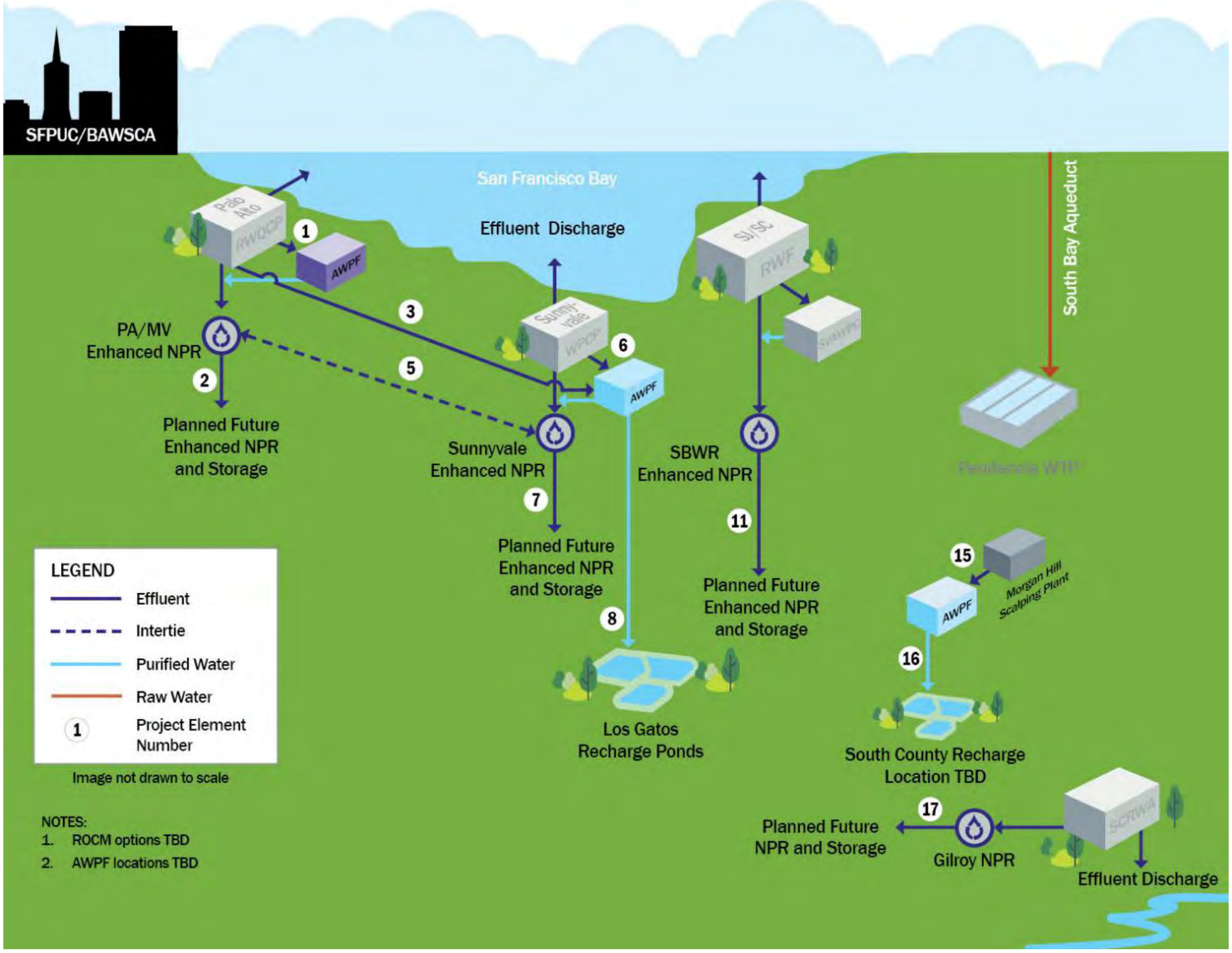

Figure 3-10. Alternative 4 elements

3.3.4.2 Flow Balance

The regional AWPF in Sunnyvale would be able to produce approximately 24,400 AFY of purified water to deliver to the LGRP. As discussed in Section 3.3.2.2, the 400 AFY surplus was assumed to be negligible. Diverting and treating wastewater in Morgan Hill would generate 2,800 AFY of purified water, less than 40 percent of the assumed capacity of the South County recharge ponds. Figure 3-11 shows the Alternative 4 flows.

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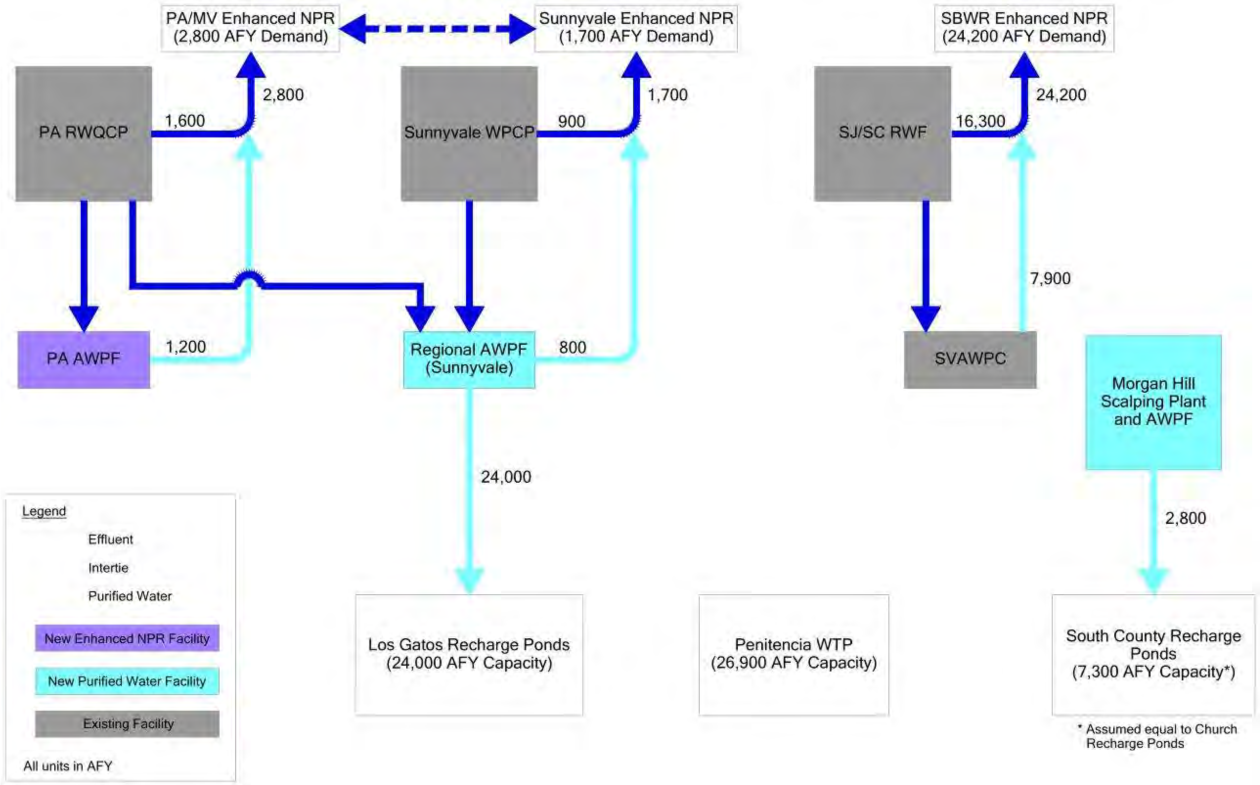
PA/MV Enhanced NPR (2,800 AFY Demand)
Sunnyvale Enhanced NPR (1,700 AFY Demand)
SBWR Enhanced NPR (24,200 AFY Demand)
PA RWQCP
1,600
2,800
Sunnyvale WPCP
900
1,700
SJ/SC RWF
16,300
24,200
7,900
PA AWPF
1,200
Regional AWPF (Sunnyvale)
800
SVAWPC
Morgan Hill Scalping Plant and AWPF
24,000
2,800
Legend
Effluent
Intertie
Purified Water
New Enhanced NPR Facility
New Purified Water Facility
Existing Facility
All units in AFY
Los Gatos Recharge Ponds (24,000 AFY Capacity)
Penitencia WTP (26,900 AFY Capacity)
South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-11. Alternative 4 purified water flow balance

3.3.4.3 Pros and Cons

As Alternative 4 proposes the same regional AWPF in Sunnyvale as Alternative 2, its potential benefits (feed reliability) and challenges (more complicated permitting, reduced supply for future NPR expansion, and limited agency experience with IPR via GWR) also carry over. The main differences are that SBWR remains separate, and Morgan Hill would implement IPR via GWR instead of NPR+. Table 3-8 highlights the pros and cons of Alternative 4 relative to other conceptual alternatives.

Table 3-8. Pros and Cons of Alternative 4

Pros	Cons
• Increased reliability for PA/MV and Sunnyvale from NPR+ intertie • Augments GW supply from regional AWPF (fed by Palo Alto RWQCP and Sunnyvale WPCP), which has greater feed reliability than an AWPF fed by Sunnyvale WPCP alone • Treating wastewater in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP • Known treatment technologies	• Capital and O&M costs related to 3 new AWPF (36,700 AFY combined purified water capacity, including Morgan Hill) and 1 intertie • Regional AWPF in Sunnyvale complicates permitting • Regional AWPF limits feed to Palo Alto AWPF, which could limit NPR expansion in PA/MV and Sunnyvale • SBWR remains separate, limiting NPR expansion in San José • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated • Diverting flow during higher demand periods could require supplemental water supply (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations • Limited agency experience in IPR via GWR

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3.3.5 Alternative 5: IPR via GWR (from Morgan Hill), DPR via raw water augmentation (from SJ/SC), and Expanded NPR

This section describes major project elements, presents a flow balance, and outlines pros and cons for Alternative 5.

3.3.5.1 Major Project Elements

Alternative 5 is similar to Alternative 1 in North County, with new AWPFs in Palo Alto and Sunnyvale for NPR+ (elements 1 and 6), allowing for connection to the SBWR system (elements 5 and 9) and NPR+ deliveries (elements 2, 7, and 11). A new AWPF would also be constructed in San José to produce purified water from SJ/SC RWF effluent (element 10); however, instead of sending purified water to the LGRP, the new SJ/SC AWPF would augment raw water at the Penitencia WTP (element 13). Similar to Alternatives 3 and 4 in South County, Morgan Hill would implement IPR via GWR (elements 15 and 16). As in Alternatives 1, 2, 3 and 4, an expanded Gilroy system (element 17) would remain separate and maintain its current NPR water quality. Figure 3-12 illustrates the major elements Alternative 5.

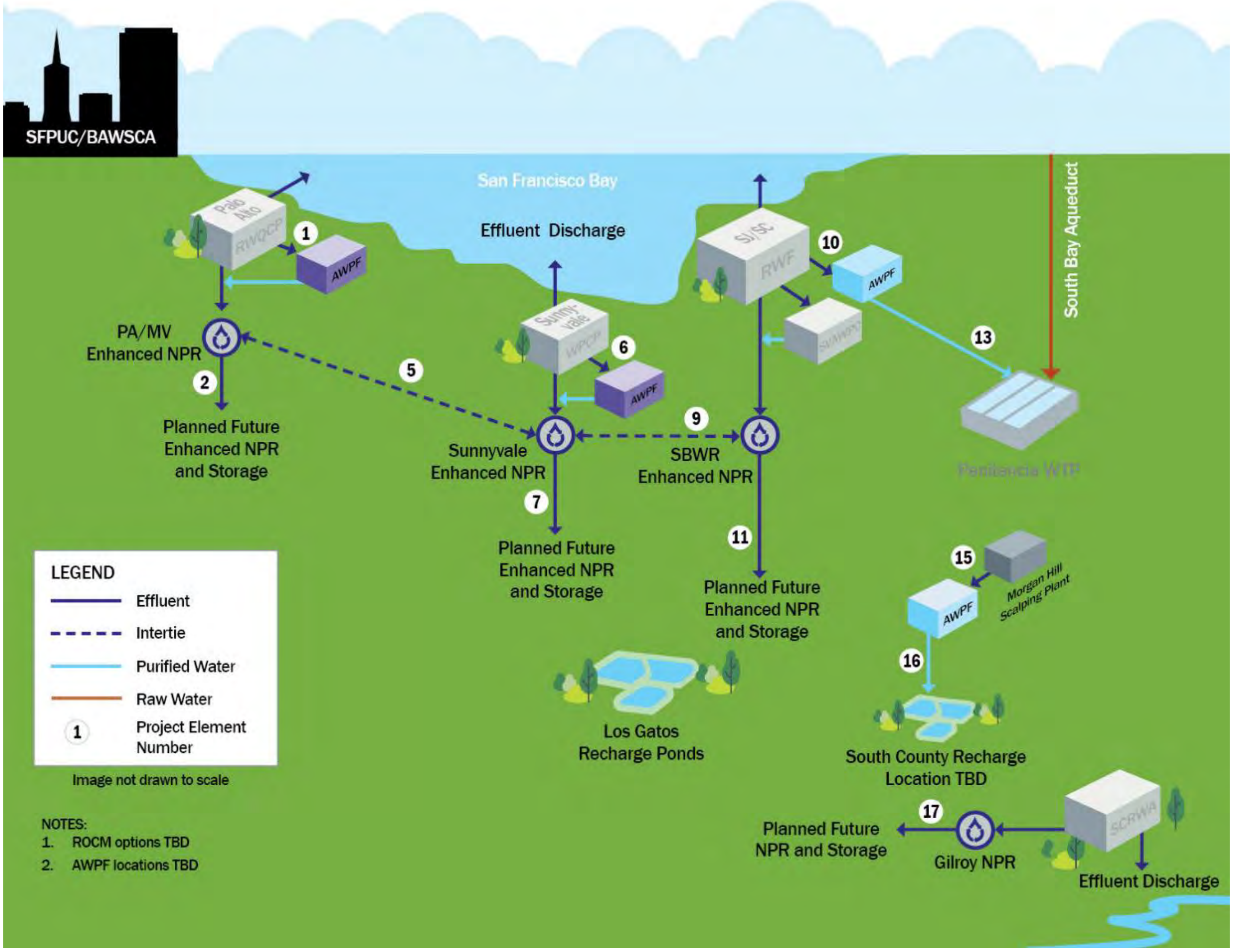

Figure 3-12. Alternative 5 elements

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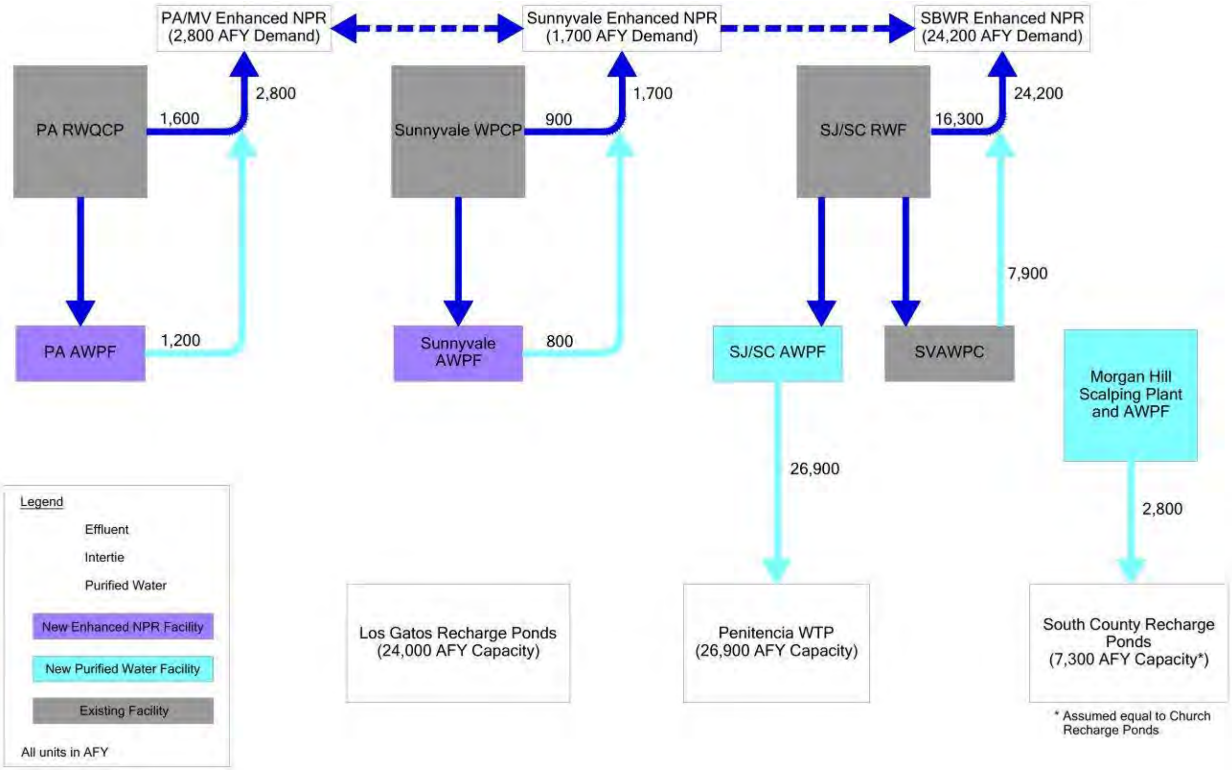
3.3.5.2 Flow Balance

The SJ/SC RWF can supply sufficient effluent volume to deliver the full 26,900 AFY of purified water to the Penitencia WTP. As with Alternatives 3 and 4, a modest volume of approximately 2,800 AFY of purified water is available for GWR in South County. These elements are shown on Figure 3-13.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PA AWPF
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South County Recharge Ponds (7,300 AFY Capacity*)
* Assumed equal to Church Recharge Ponds

Figure 3-13. Alternative 5 purified water flow balance

3.3.5.3 Pros and Cons

Alternative 5 shares the NPR benefits of Alternative 1—increased reliability and recycled water quality. Although potable water reliability improves with raw water augmentation at the Penitencia WTP, substituting DPR for IPR via GWR is a risk when regulations are still in progress. Ultimately, implementing DPR may require additional facility improvements, especially related to treatment, monitoring, and operations. These additional improvements, combined with relatively high purified water production capacity, would further increase costs beyond those of other alternatives. Table 3-9 highlights the pros and cons of Alternative 5 relative to other conceptual alternatives.

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Table 3-9. Pros and Cons of Alternative 5

Pros	Cons
• Increased reliability in North County from NPR+ interties • Greater reliability for potable water than the other alternatives • Augments GW from single facility and agency experienced in GWR • Separate AWPFs allow for streamlining implementation • Treating wastewater flow in Morgan Hill could reduce need to construct new trunk sewer from Morgan Hill to SCRWA WWTP	• Capital and O&M costs related to 4 new AWPFs (39,600 AFY combined purified water capacity, including Morgan Hill) and 2 interties • Costly improvements for DPR and purified water production capacity and monitoring (highest of all alternatives) • DPR regulations are not yet established • Morgan Hill satellite plant and AWPF may require extensive permitting and present staffing/resource challenges • Morgan Hill AWPF RO concentrate management feasibility has not been fully evaluated • Unknown additional technologies for achieving DPR level of treatment • Diverting flow in Morgan Hill during higher NPR demand periods could require supplemental water supply in Gilroy area (e.g., well) • Reduced/altered flow to SCRWA WWTP could impact operations

3.3.6 Summary

Table 3-10 compares purified water flows among alternatives, rounded to the nearest 100 AFY. Because NPR+ deliveries are equal between alternatives, the table focuses on combined flows for PR (LGRP, Penitencia WTP, and South County recharge ponds). Available purified water from SJ/SC RWF effluent depends on whether Morgan Hill develops an NPR+ system (Alternatives 1 and 2); thus, these cases are treated separately.

Table 3-10. Purified Water Available for PR Alternatives

Supply Source	Source Water Available for PR, Considering Treatment Losses[a] (AFY)	Purified Water Provided for PR (AFY)[b]				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Palo Alto RWQCP	14,100[c]	0	14,000	14,100	14,000	0
Sunnyvale WPCP	10,300[c]	0	10,000	0	10,000	0
SJ/SC RWF • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	 71,800[e] 74,300[e]	 24,000 N/A	 0 N/A	 N/A 0	 N/A 0	 N/A 26,900
SCRWA Service Area • Potential Future Morgan Hill AWPF and Satellite Plant	2,800	0	0	2,800[f]	2,800[f]	2,800[f]
County total • With Morgan Hill NPR+ [d] • Without Morgan Hill NPR+	 99,000 101,500	 24,000 24,000	 24,000 24,000	 17,000[g] 17,000[g]	 26,800 26,800	 29,700 29,700
PR locations		LGRP	LGRP	LGRP, South County recharge ponds	LGRP, South County recharge ponds	Penitencia WTP, South County recharge ponds

a. Assumes that all remaining effluent is available as feed water for an AWPF; blending or discharge requirements will be further considered as the Master Plan progresses, along with potential new contractual agreements. Treatment losses account for advanced treatment recovery rates.
b. Purified water provided is limited to recharge capacity or treatment capacity of receiving facility.
c. Based on high estimates of future losses and potential environmental flows.
d. Alternatives 1 and 2 include Morgan Hill NPR+. Alternatives 3, 4, and 5 do not.
e. Per the assumptions in the Baseline Analysis TM, no potential environmental flows were considered for SJ/SC RWF.
f. Delivered to recharge ponds in South County; exact location TBD.
g. Difference due to rounding.
N/A = not applicable.

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Alternative 5 delivers the most purified water for PR, a result of the higher capacity at the Penitencia WTP relative to the LGRP. Alternative 3 delivers the least because Palo Alto alone cannot meet the LGRP capacity.

Source water flow projections—and consequently, projected purified water production—may be refined as new information (e.g., updated NPR demand projections) becomes available.

Section 4: Process for Prioritization and Assessment

This section describes the approach to prioritizing and assessing conceptual alternatives.

4.1 Methodology

The process for prioritization and assessment begins with selecting criteria and identifying the respective weight of each criterion (weighting factor) to apply when evaluating alternatives. Assessing alternatives through the lens of each criterion helps to illuminate their relative strengths and weaknesses.

Valley Water developed initial criteria considering objectives of the Master Plan and typical criteria of funding opportunities with the U.S. Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) with the goal of striking a balance across these considerations. Table 4-1 illustrates the relationship between the Master Plan objectives and typical criteria of Reclamation and DWR funding opportunities.

Table 4-1. Objectives Considered When Developing Criteria

Theme	Countywide Master Plan Objectives	Reclamation Funding	DWR Funding
Increase water reuse supply	Determine reuse supply availability and benefits. Identify sources and amounts of water available for reuse; the appropriate split between NPR and PR; and regional, Valley Water, and local-level benefits from NPR and PR.	• Increase water supplies and reduce demand on non-recycled water supplies.	--
Promote regional solutions	Evaluate potential regional integration. Facilitate innovative approaches and collaboration for residuals management, permitting, and land use decisions. Optimize use of supply and infrastructure, improve system reliability and flexibility, and explore redefining sewersheds.	• Address water supply sustainability. • Promote a watershed perspective/integrated resources management. • Improve habitat and water quality.	• Consider Integrated Regional Water Management Plan implementation (regionalism, partnerships, and integration). • Address multiple goals. • Reduce dependence on the Delta.
Governance and economics	Guide system expansion through interagency agreements and governance. Analyze the economics of project alternatives and explore cost-sharing opportunities.	• Complete authorized Title XVI projects. • Implement cost-effective projects. • Meet legal and contractual water supply obligations.	• Integrate multiple resource management strategies. • Optimize project costs and financing. • Demonstrate technical and economic feasibility.
Social issues/public acceptance	Generate regional support for the Master Plan via coordination and outreach. Improve public perception of water reuse through outreach programs.	• Provide benefits to rural or economically disadvantaged communities (DAC).	• Provide benefits to DAC and Native American tribal community water issues. • Consider environmental justice.
Readiness to proceed	--	• Promote projects that are ready to proceed.	• Promote projects that are ready to proceed.
Climate change	--	• Incorporate use of renewable energy and promote energy efficiency.	• Incorporate climate change adaptation, including reduction in GHG emissions.

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Valley Water aligned objectives based on common themes, aggregated them into initial prioritization criteria, and assigned initial weighting factors by criterion. Assigning weighting factors to criteria helps reflect the values and preferences of stakeholders and decision makers when assessing and prioritizing project alternatives. Consistent with standard decision-making approaches, weighting factors varied by criterion.

4.2 Criteria and Weighting

During a PPG meeting held June 21, 2018, Partner Agencies provided input to Valley Water on the initial criteria and weighting factors. Based on Partner Agencies' feedback, Valley Water refined and confirmed prioritization criteria and respective weighting, as summarized in Table 4-2.

Table 4-2. Prioritization Criteria and Weighting

Criterion	Notes	Weighting
Economics	Including capital and O&M costs and rate/customer affordability impacts	25%
Groundwater management and countywide (regional) supply reliability	Including groundwater protection (quality and quantity) and dry year/drought resilience benefits	25%
Environmental impacts/benefits and sustainability	Including environmental impacts/benefits, energy use, and GHG production	20%
Ease of implementation and permitting/regulatory considerations	Including governance/partnership, public acceptance, permitting/compliance, environmental and social justice, timing (readiness to proceed), and staff resource considerations	15%
Engineering feasibility	Including water quality (source and product water), monitoring requirements, and treatment technology	15%
	Total	100%

4.3 Ranking

The conceptual alternatives identified in Section 3 were evaluated relative to each criterion listed in Table 4-2. Each alternative was awarded a score between 1 and 5 based on how well it satisfies each individual criterion, as described further in Section 5. The alternatives' relative rankings were used to identify three alternatives to be carried forward to feasibility-level assessment.

Section 5: Outcomes of Alternatives Ranking and Selection

This section presents the outcomes of the alternatives ranking and selection process.

5.1 Conceptual Alternatives Evaluation

Each conceptual alternative was scored initially by the project team and refined with input from Valley Water and the PPG. Scores were applied using the scale summarized in Table 5-1 and with respect to the considerations listed below.

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Table 5-1. Scale for Scoring Conceptual Alternatives

Score	Evaluation Criteria				
	Economics	GW Management and Countywide (Regional Supply Reliability)	Environmental Impacts/Benefits and Sustainability	Ease of Implementation and Permitting/Regulatory Considerations	Engineering Feasibility
5	$	Highest volume for potable reuse; interties for supply reliability	Positive environmental benefit	Reuse regulations in place. Experienced with operational requirements. Few or no agreements required.	Permitted and proven on respective water reuse application. Short pipelines through developed areas.
4	$$	High volume for potable reuse; interties for supply reliability	Neutral benefit/impact	Reuse regulations in development. Some experience with technology and operational requirements. Few agreements required.	Permitted and proven on drinking water; demonstrated but not yet permitted for respective potable reuse applications.
3	$$$	Sufficient volume for potable reuse; some interties for supply reliability	Minimal environmental concerns	Reuse regulatory framework and timeline in place. Limited experience with technology and operational requirements. Some agreements required.	Treatment approach in demonstration-scale (further commitment over pilot).
2	$$$$	Low volume for potable reuse; few interties for supply reliability	Moderate impacts requiring mitigation	Reuse regulatory framework anticipated. No experience with technology and operational requirements. Multiple agreements required.	Treatment approach in pilot-scale.
1	$$$$$	Lowest volume for potable reuse; few/no interties for supply reliability	Significant environmental impacts	No regulations in place or on horizon. No experience with operational requirements. Many agreements required.	Concept or research-based treatment technology. Complex/unfamiliar operational requirements. Long pipelines through urban, developed areas.

Economics. New advanced treatment facilities, distribution systems, and pipelines add capital and O&M costs. Costs will be fleshed out in the feasible portfolios evaluation, along with effects on water rates and local economy. For the purpose of this assessment, conceptual alternatives are scored relative to one another. Alternatives that incorporated extensive new infrastructure scored lower in this category than alternatives that leveraged existing facilities and had fewer new facilities.

GW Management and Countywide (Regional) Supply Reliability. Per the guiding principles, alternatives should incorporate a mix of NPR and PR and add volume for PR. Alternatives that added a larger volume for PR were scored higher in this category than alternatives with less volume committed to PR. For this evaluation, it is assumed that all alternatives will incorporate requirements to maintain GW quality protection; thus, this is not a differentiator among alternatives.

Environmental Impacts/Benefits and Sustainability. The potential impacts of an alternative on the environment (positive or negative) include energy consumption, quantity and quality of flows to receiving water bodies, and ease of adaptation to changes in physical or statutory conditions (e.g., climate change, catastrophic events, population or economic growth, regulatory changes). Lower scores were applied to alternatives with multiple AWPFs that have higher energy requirements for RO, resulting in higher GHG production, and to those that may adversely affect existing environmental conditions of receiving water bodies.

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Ease of Implementation and Permitting/Regulatory Considerations. This criterion weighs the potential effects (positive or negative) of an alternative on the local community, specifically DACs, and the acceptability of the measure to customers/ratepayers and local interest groups. Alternatives that have known reuse permitting pathways and environmental documentation requirements were scored higher than those with more complex requirements or regulations that are new or still in development. Lower scores were given to alternatives that had longer project implementation timelines or more complex staffing/operational requirements.

Engineering Feasibility. The alternatives generally involve similar project components in terms of equipment, technology, and water quality goals; however, their scales (i.e., capacity, length, and number of facilities) vary. Alternatives including the Morgan Hill satellite plant and AWPF received a lower score because of the additional unit processes needed for primary and secondary treatment of wastewater. Long pipelines through heavily congested areas can be challenging during construction, as reflected in lower scores in this area.

The scoring for each alternative is summarized in Table 5-2.

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Table 5-2. Conceptual Alternatives' Scores

Criterion	Notes	Weighting	Conceptual Alternative 1		Conceptual Alternative 2		Conceptual Alternative 3		Conceptual Alternative 4		Conceptual Alternative 5	
			Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning	Score	Scoring Reasoning
Economics	Including capital and O&M costs and rate/customer affordability impacts	25%	3.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 34,900 AFY (24,000 AFY for PR and 10,900 AFY for NPR+); 3 intertie pipes; and new Morgan Hill NPR+ distribution system	3.0	Capital and O&M costs related to: 2 new AWPFs with combined purified water capacity of 34,900 AFY (24,000 AFY for PR and 10,900 AFY for NPR+); 3 intertie pipes; and new Morgan Hill NPR+ distribution system	2.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 26,900 AFY (17,000 AFY for PR and 9,900 AFY for NPR+); 1 intertie pipe; new pipe from Palo Alto to Los Gatos; limited land availability in Palo Alto; and new Morgan Hill satellite plant and AWPF	3.0	Capital and O&M costs related to: 3 new AWPFs with combined purified water capacity of 36,700 AFY (26,800 AFY for PR and 9,900 AFY for NPR+); 1 intertie pipe; new Morgan Hill satellite plant and AWPF	1.0	Capital and O&M costs related to: 4 new AWPFs with combined purified water capacity of 39,600 AFY (29,700 AFY for PR and 9,900 AFY for NPR+); DPR treatment/monitoring; 2 intertie pipes; new Morgan Hill satellite plant and AWPF
GW management and countywide (regional) supply reliability	Including GW protection (quality and quantity) and dry year/drought resilience benefits	25%	3.0	Augments GW supply from SJ/SC (large volume); interties provide drought resilience	3.0	Augments GW supply (combined volume) from Sunnyvale and Palo Alto; interties provide drought resilience	2.0	Augments GW supply from Palo Alto, though with less water than other alternatives; intertie provides drought resilience	4.0	Augments GW supply (combined volume) from Sunnyvale & Palo Alto; intertie between Sunnyvale and Palo Alto provides drought resilience; no intertie with SBWR	5.0	Augments surface water from SJ/SC; reoperation would direct more imported water to recharge due to DPR; interties provide drought resilience
Environmental impacts/benefits and sustainability	Including environmental impacts/benefits, energy use, and GHG production	20%	4.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	4.0	2 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	3.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	4.0	3 new, separate AWPFs for NPR+ and IPR; local supplies could offset increased imports, reducing GHG overall for water deliveries	2.0	4 new, separate AWPFs for NPR+ and DPR; local supplies could offset increased imports, reducing GHG overall for water deliveries
Ease of implementation and permitting/regulatory considerations[a]	Including governance/partnership, public acceptance, permitting/compliance, environmental and social justice, timing (readiness to proceed), and staff resource considerations	15%	5.0	SCP agreement may expire; agency experienced in GWR and using a single facility	4.0	SCP agreement may expire; limited or no agency experience in PR	2.0	New Morgan Hill satellite plant and AWPF may require extensive permitting; limited land availability in Palo Alto	3.0	New Morgan Hill satellite plant and AWPF may require extensive permitting	1.0	DPR regulations anticipated in 2023; DPR has no precedent in California; new Morgan Hill satellite plant and AWPF may require extensive permitting
Engineering feasibility	Including water quality (source and product water), monitoring requirements, and treatment technology	15%	4.0	Known technologies for achieving level of treatment; pipeline(s) through developed urban areas	4.0	Known technologies for achieving level of treatment; pipeline(s) through developed urban areas	3.0	Known technologies for achieving level of treatment; however, adding new Morgan Hill satellite plant and AWPF may present staffing/ resource challenges	3.0	Known technologies for achieving level of treatment; however, adding new Morgan Hill satellite plant and AWPF may present staffing/ resource challenges	1.0	Unknown additional technologies for achieving DPR-level of treatment; new Morgan Hill satellite plant and AWPF may present staffing/resource challenges
	Total	100%	3.7		3.5		2.4		3.5		2.2	

a. *Permitting and regulatory considerations are discussed in more detail in the Regulatory Compliance Strategy.*

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5.2 Feasible Alternatives Selection

Based on the results of the scoring process, the three alternatives selected to move forward to feasible alternatives evaluation are:

- **Alternative 1:** IPR via GWR (from SJ/SC) and expanded NPR
- **Alternative 2:** IPR via GWR (from Palo Alto /Sunnyvale) and expanded NPR
- **Alternative 4:** IPR via GWR (from Palo Alto/Sunnyvale and Morgan Hill) and expanded NPR

These alternatives will be refined and further evaluated in the feasible portfolios evaluation.

Section 6: Next Steps

The three alternatives selected to move forward to feasible portfolios evaluation will be developed to a preliminary (10 percent) design and further evaluated using detailed prioritization criteria and other factors, such as economics, environmental impacts/benefits, governance considerations, and risk.

Valley Water will continue to facilitate meetings and workshops with the PPG, Executive Leadership Group, Stakeholder Task Force, and the Board Recycled Water Committee to discuss and refine the Draft Master Plan Report. The Final Master Plan Report will be developed in close coordination with these partners and stakeholders.

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Attachment A: Market Assessment

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This attachment presents the market assessment used for the conceptual alternatives analysis. Note that while potential costs are referenced where available from source studies, costs are not a consideration for conceptual alternatives. Costs will be evaluated as part of the feasibility analysis.

A.1 PA/MV RWS

The PA/MV RWS delivers recycled water produced at the Palo Alto RWQCP to customers in Palo Alto and the North Bayshore area of Mountain View.

A.1.1 Palo Alto

The City of Palo Alto's 2008 Recycled Water Facility Plan (RWFP) identified 1,700 AFY in potential additional demand and organized potential customers into five geographic areas, shown on Figure A-1. The pink circles represent potential customers, with higher demands corresponding to larger circles. Arrows represent options for future expansion.

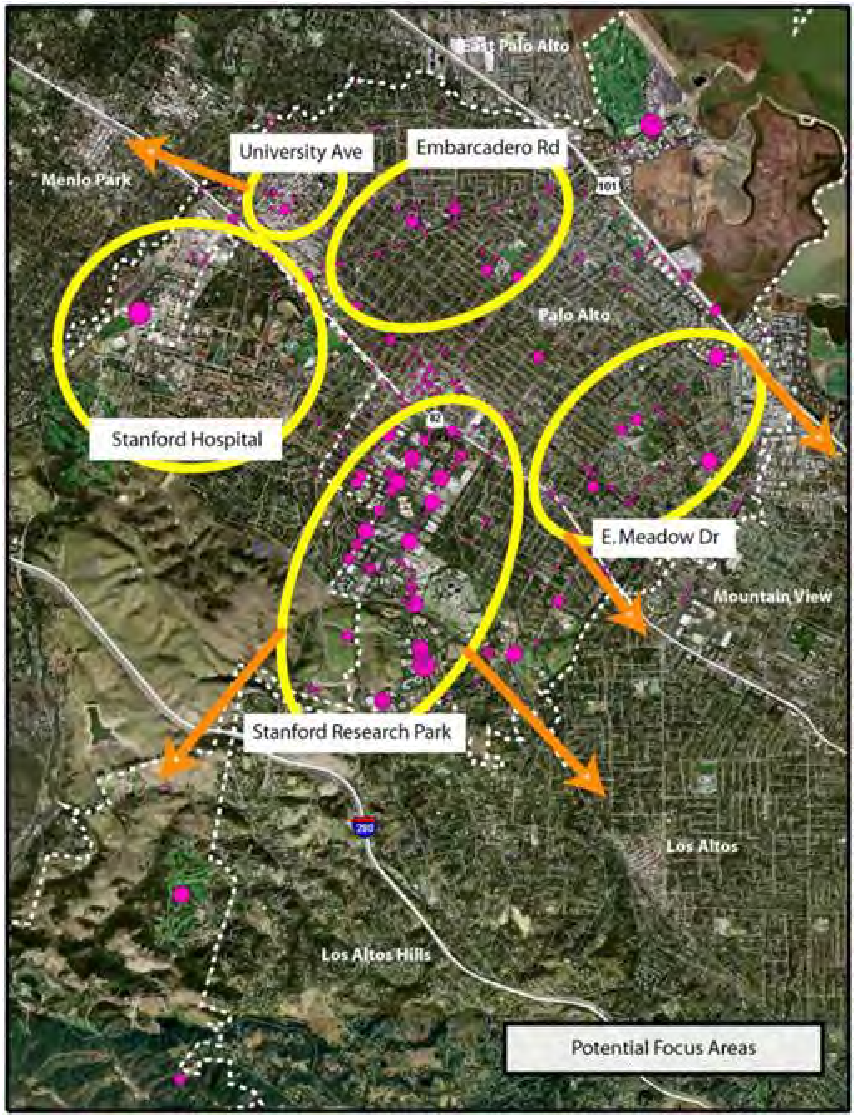

Figure A-1. Palo Alto: groupings of potential NPR customers

Source: 2008 RWFP

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The highest concentration of users is in the Stanford Research Park area, which is the focus of the plan. To serve these customers, the 2008 RWFP recommended connecting to the existing pipeline along East Bayshore Road (shown on Figure A-2) and proceeding southwest. This extension would add 900 AFY of demand, which matches the City's 2015 UWMP projection. The 2015 UWMP estimated long-term NPR demand at 1,750 AFY.

Figure A-2 illustrates the expected demand and recommended facilities to serve the East Meadow Drive and Stanford Research Park focus areas. According to the 2008 RWFP, the total capital cost (including pipelines, pumping, and user retrofits) for the recommended project is $33.5 million in 2008 dollars.

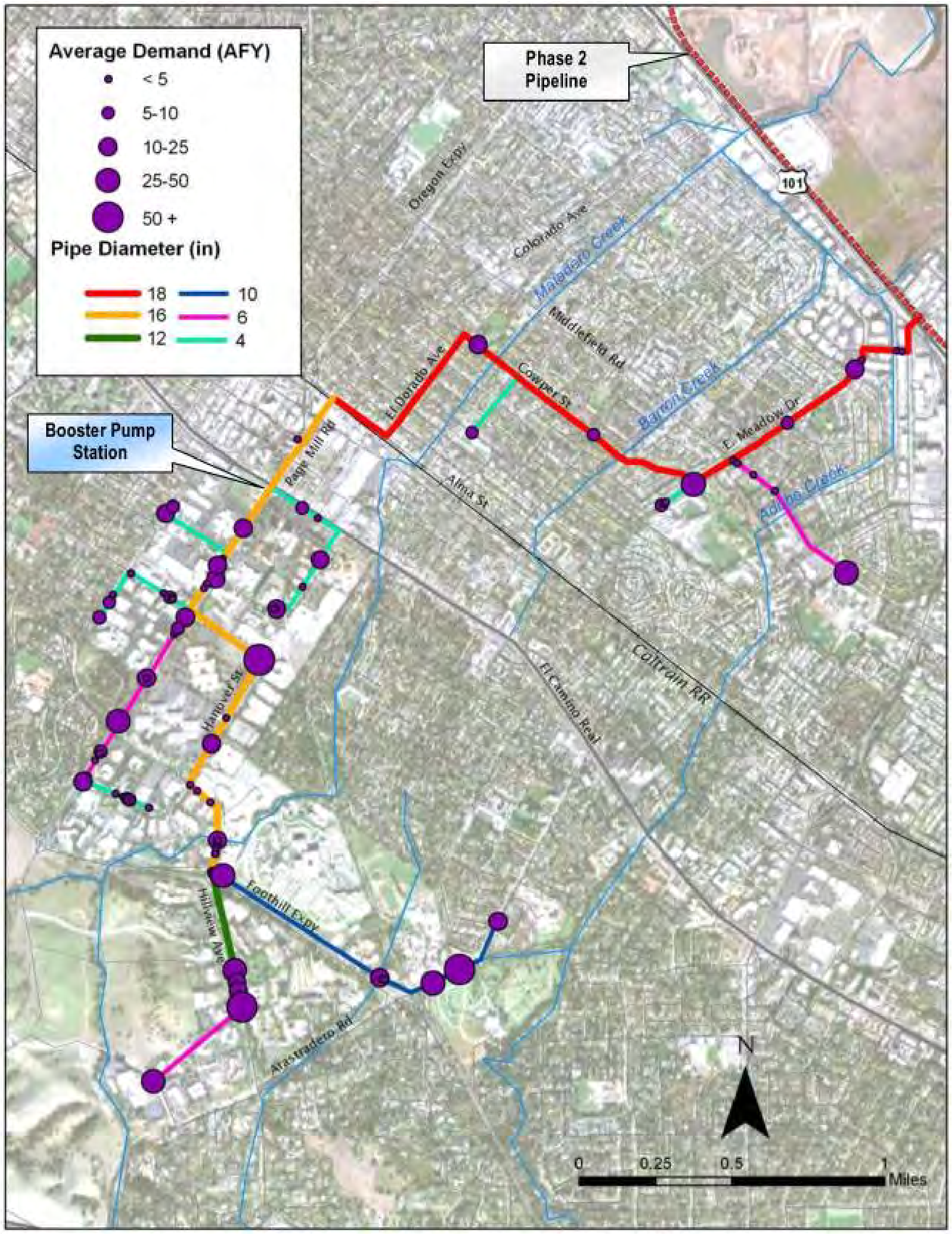

Figure A-2. Palo Alto: recommended NPR facilities

Source: 2008 RWFP

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A.1.2 Mountain View

The City of Mountain View's 2014 Recycled Water Feasibility Study (RWFS) identified five system expansion alternatives. Shown in Figure A-3, proposed options target larger potential users south of Highway 101, including the Domizile Homeowners Association, Rengstorff Park, Cuesta Park, and El Camino Hospital.

Additionally, the 2014 RWFS identified a potential intertie between the City of Mountain View and City of Sunnyvale recycled water distributions systems. This intertie would cross through Moffett Field and connect to the City of Sunnyvale near Enterprise Way. The alignment for this intertie is also shown on Figure A-3.

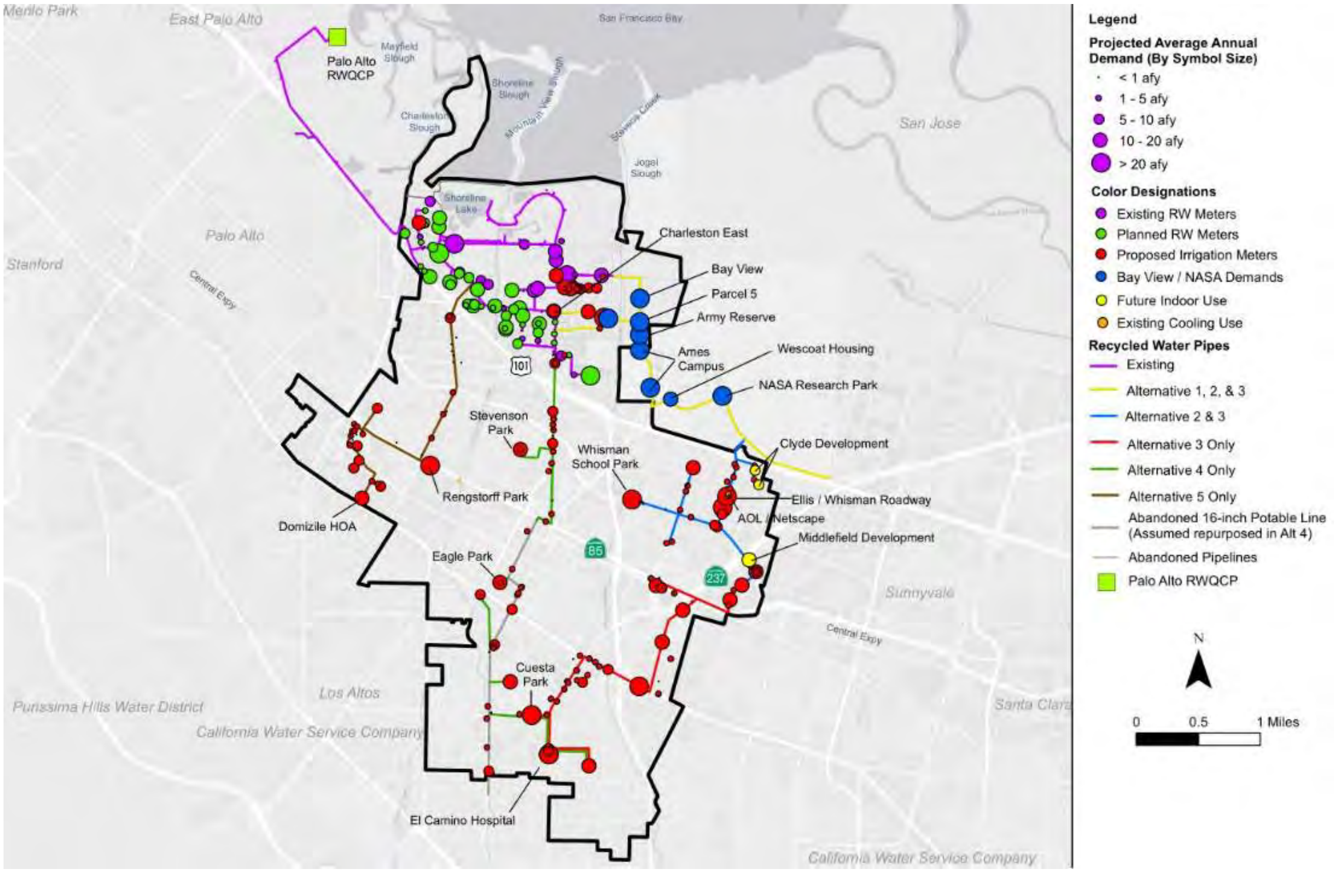

Figure A-3. Mountain View: NPR expansion alternatives

Source: 2014 RWFS

With the lowest unit costs ($2,650/AF [2014 dollars]) and relatively minimal environmental impacts, the National Aeronautics and Space Administration (NASA) Research Park and Whisman School Park alignments were selected for implementation. These correspond to the yellow and blue lines in Figure A-3. Because of financial challenges of implementing the expansion at once, the 2014 RWFS proposed dividing the project into three phases. In all, the recommended project would cost $23.7 million (2014 dollars) and add approximately 1,100 AFY of demand, for a total of 1,600 AFY. These demands include approximately 400 AFY delivered to users outside the City of Mountain View's water service area, which are associated primarily with Moffett Field.

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The City of Mountain View's 2015 UWMP projects a total long-term demand of 2,500 AFY, nearly 1,000 AFY more than the 2014 RWFS. Part of the discrepancy can be explained by projected deliveries outside the water service area, which are approximately four times larger in the 2015 UWMP. Meanwhile, projected deliveries inside the water service area are lower in the 2015 UWMP. The 2015 UWMP noted that estimates from the 2014 RWFS were updated based on "subsequent discussions with NASA, Google, and the City of Sunnyvale." Table A-1 compares the long-term demand projections by service area between the 2014 RWFS and 2015 UWMP.

Table A-1. Comparison of Projected Long-Term NPR Demands in Mountain View

Source	Inside Water Service Area (AFY)	Outside Water Service Area (AFY)	Total (AFY)
2014 RWFS	1,200	400	1,600
2015 UWMP	1,100	1,400	2,500

A.2 Sunnyvale RWS

The Donald M. Somers WPCP supplies the Sunnyvale RWS, which delivers water to customers in the cities of Sunnyvale and Cupertino.

A.2.1 Sunnyvale

In 2013, the City of Sunnyvale adopted a Feasibility Study for Recycled Water Expansion (FSRWE), which identified approximately 2,100 AFY of additional potential recycled water demand. The recommended expansion included creating a system loop via extensions to Washington Park, Las Palmas Park, and apartment complexes on South Fair Oaks Avenue, as well as an extension south on Wolfe Road to the Apple Campus 2. The total cost of the recommended expansion, including all optional extensions, was estimated at $114.1 million (2013 dollars). The Wolfe Road Main was completed in 2017, with funding help from Valley Water, Apple, and California Water Service Company (Cal Water). Figure A-4 shows the existing and proposed NPR system, color coded by construction phase.

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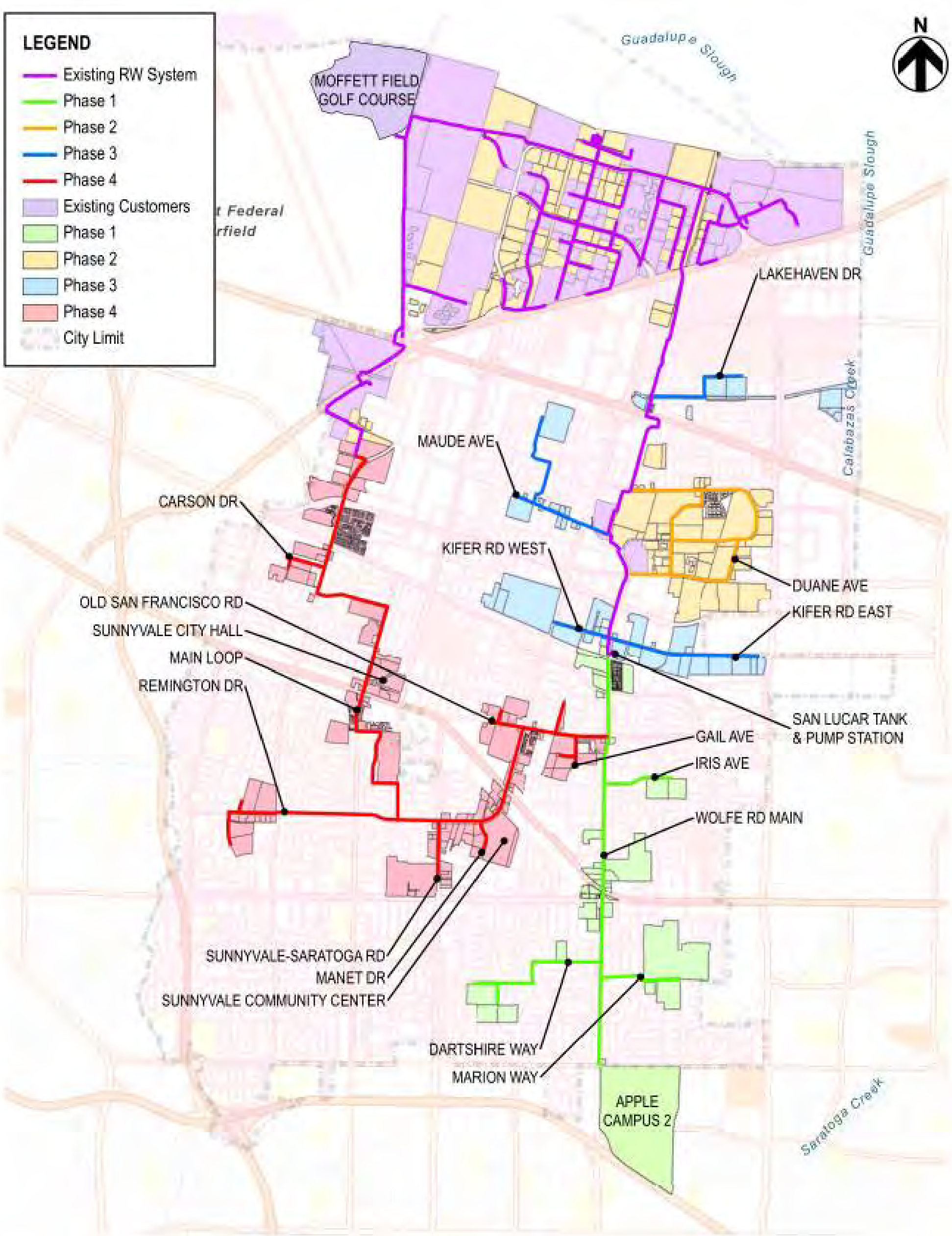

Figure A-4. Sunnyvale: NPR expansion and phasing

Source: 2013 FSRWE

The 2013 FSRWE estimates total long-term NPR demand reaching 3,100 AFY, compared to only 1,700 AFY in the 2015 UWMP. Following completion of the 2013 FSRWE, the City of Sunnyvale chose to not pursue additional recycled water projects until further direction from Valley Water was received regarding countywide recycled water planning. This reduced the NPR demand in the City of Sunnyvale's 2015 UWMP. The 2015 UWMP projects reaching 1,680 AFY by 2030, with no further demand growth beyond 2030. Most of the growth is due to increased landscape irrigation and dual plumbing, with less significant contributions from golf course irrigation and construction operations.

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A.2.2 Cupertino

Cal Water, along with San Jose Water (SJW) under a lease agreement with the City, retails potable water within the city of Cupertino. In 2012, SJW developed a *Recycled Water Feasibility Study* (RWFS) that investigated bringing recycled water to the city of Cupertino and western portion of the city of San José. Alignment T, as the extension was named, would utilize recycled water from the City of Sunnyvale's RWS, connecting near the Apple Campus 2. The 2012 RWFS proposed constructing Alignment T in three phases, costing $38.8 million (2012 dollars) and serving a total potential demand of 1,300 AFY. Figure A-5 shows proposed and optional Alignment T segments, along with target customers.

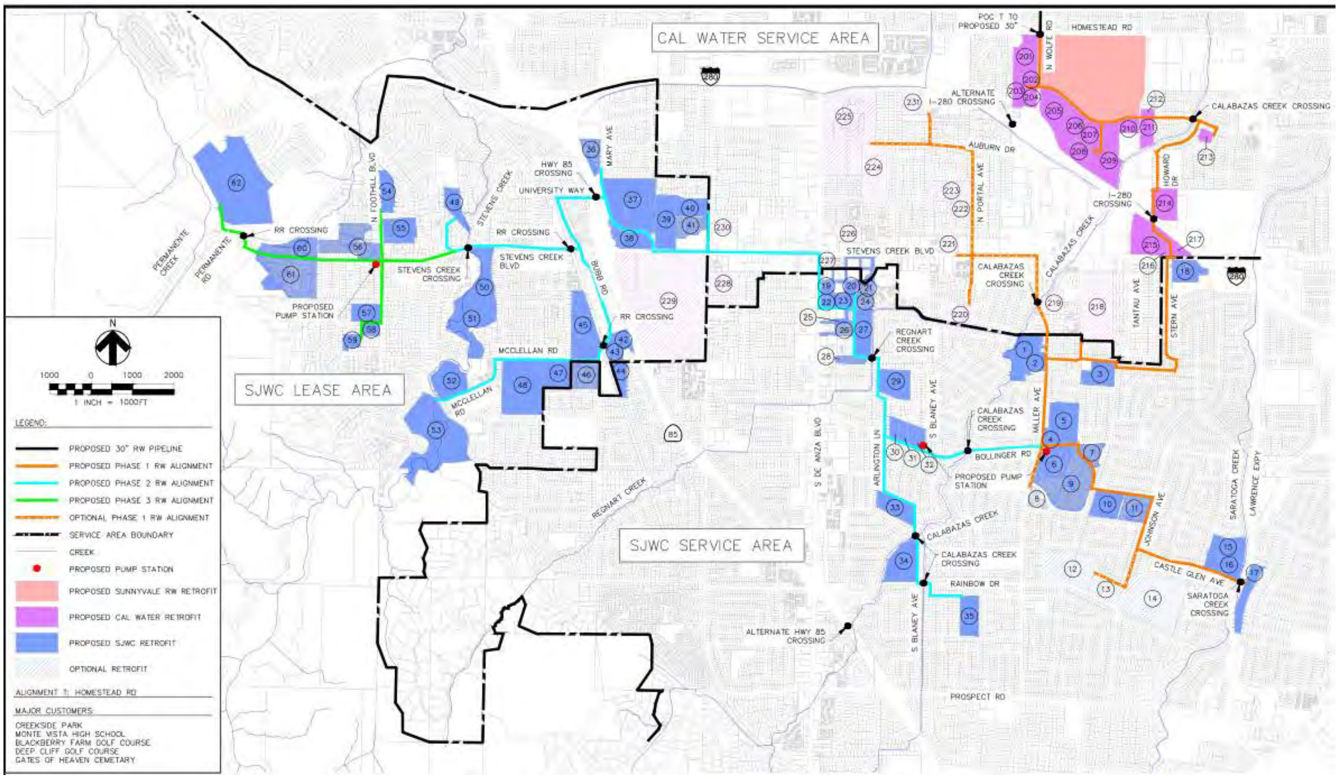

Figure A-5. Cupertino (Cal Water/SJW): proposed Alignment T facilities

Source: 2012 RWFS

Because SJW provides water service to Cupertino through a lease agreement that expires in 2022, it was not considered feasible to invest in Alignment T unless an agreement was in place to make this a financially viable option. Therefore, SJW did not include Cupertino NPR demands in its 2015 UWMP.

Cal Water's 2015 UWMP recycled water use projections include only Apple Campus 2 deliveries, which reach approximately 300 AFY by 2025. No additional demand growth is expected through 2035.

A.3 SBWR

SBWR delivers recycled water produced at SJ/SC RWF to customers in the cities of Santa Clara, San José, and Milpitas.

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A.3.1 Santa Clara

While the City of Santa Clara does not plan to expand its recycled water distribution system, NPR demand is expected to almost double by 2040 according to the City of Santa Clara's 2015 UWMP. The City of Santa Clara attributes the growth to a burgeoning data center industry, which uses large volumes of water for cooling. In addition, the City of Santa Clara expects significant development and several infill projects near existing pipelines, creating additional landscape irrigation and dual plumbing demand. Figure A-6 shows the actual and projected NPR demand from 1998 through 2040, when demand is expected to reach 6,900 AFY. In 2035, the target year for long-term demand comparisons, NPR demand is estimated at 6,500 AFY.

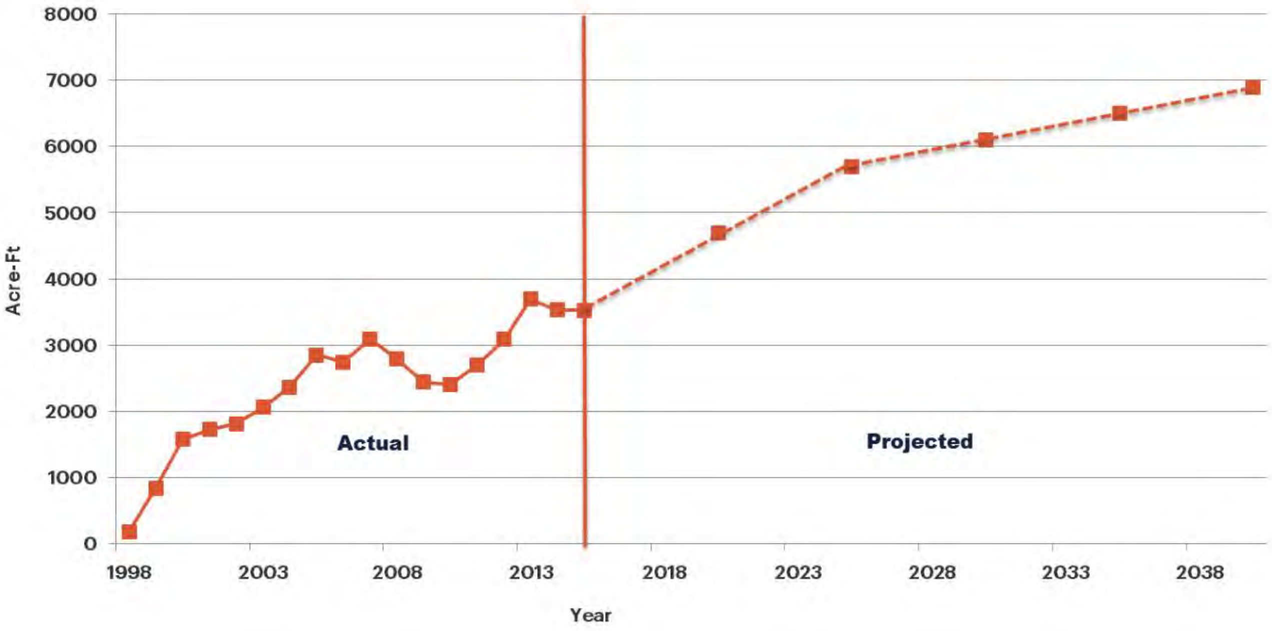

Figure A-6. Santa Clara: actual and projected recycled water demand

Source: Santa Clara 2015 UWMP

A.3.1.1 San José Municipal Water System

The San José Municipal Water System (SJMWS), one of the two NPR service providers in the city of San José, has not developed its own recycled water plan; however, SBWR conducted a market assessment of its service area in the 2014 SMP. The 2014 SMP projected approximately 2,700 AFY in additional demand, for a long-term total of approximately 7,300 AFY within the SJMWS service area. Increased demand is based on job and housing growth scenarios introduced in the *Envision San José 2040 General Plan Update* and is not associated with any specific recycled water expansion projects. Of note, the 2013 expansion of the Los Esteros Energy Center was expected to contribute between 1,000 and 2,000 AFY of additional demand (1,500 AFY was used in the SMP), a significant portion of the projected overall growth.

SJMWS's 2015 UWMP projects demand nearly doubling from 3,600 AFY in 2015 to 6,800 AFY in 2035. This total long-term demand is lower than SBWR's estimate, though 2040 estimates from the 2015 UWMP are right in line with SBWR. Both landscape irrigation (including golf courses) and industrial use are expected to increase, but industrial use will exceed irrigation demand in 2020 and grow more quickly in the following years.

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A.3.1.2 San Jose Water

SJW, the other NPR service provider in the city of San José, developed a *Recycled Water Master Plan* (RWMP) in 2009 that identified 17 potential alignments to expand the RWS throughout SJW's service area. A 2011 TM, the Recycled Water Master Plan – 2011 Update refined the 2009 market assessments and introduced two new alignments, for a total of 19. Through 2018, nine of the alignments proposed in the 2009 RWMP had been implemented, representing approximately 27 miles of new infrastructure. Constructing the remaining alignments would cost approximately $130.7 million (2011 dollars) and increase total irrigation demand by 5,600 AFY. Proposed alignments are shown on Figure A-7.

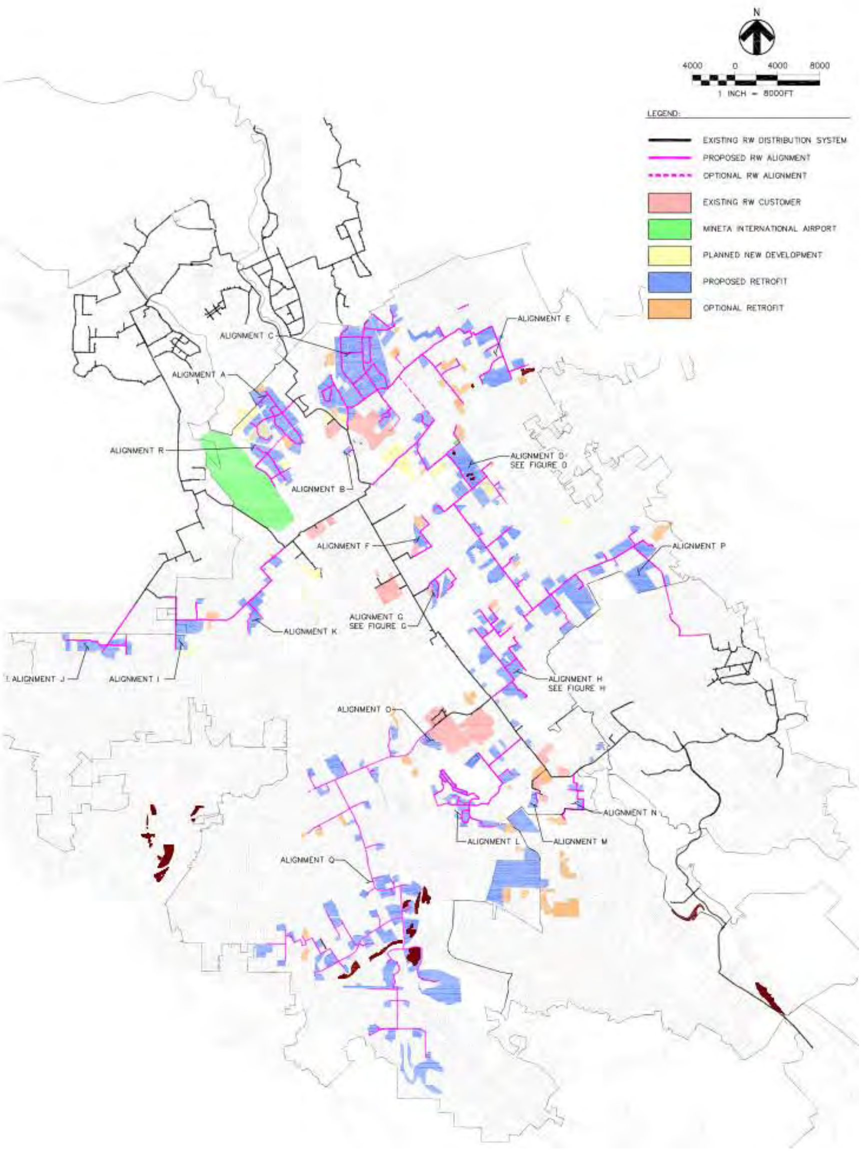

Figure A-7. San Jose Water: proposed recycled water alignments

Source: 2011 RWMP

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SJW's 2015 UWMP updated the demand estimates and proposed an implementation schedule for each alignment. Alignments A and R would be implemented first in 2016, with Alignment K completing the expansion plan in 2029. As mentioned in the Cupertino discussion, Alignment T was not included in the UWMP. Together, the extensions would increase demand by 6,400 AFY, for a total long-term demand of 8,400 AFY, achieved by 2035.

A.3.1.3 Milpitas

SBWR's 2014 SMP summarizes the City of Milpitas's long-term recycled water demands, which are expected to increase because of development around the Milpitas Transit Area and system extensions to Spring Valley Golf Course and Summitpointe Golf Club. These developments, along with an effort to convert cooling towers to use recycled water, combine for approximately 1,100 AFY in additional long-term demand. Total potential demand is 2,200 AFY. The 2014 SMP cites an aggregate cost for the entire SBWR system, so no Milpitas-specific costs are available for reference. Figure A-8 illustrates the proposed distribution facilities.

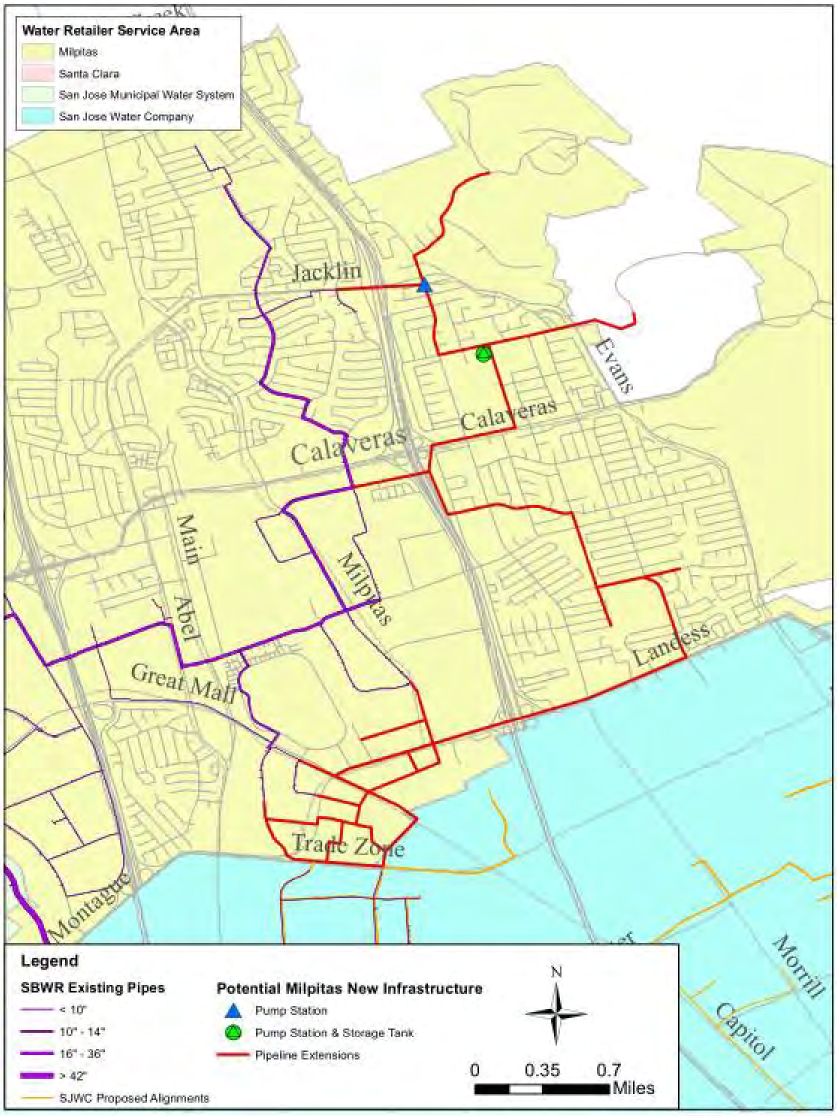

Figure A-8. Milpitas: proposed recycled water infrastructure

Source: SBWR 2014 SMP, Appendix 3A

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The City of Milpitas's 2015 UWMP projects more aggressive demand growth. While SBWR's SMP estimates an NPR demand of 2,200 AFY in its long-term projections (defined as 2035), the 2015 UWMP projects 2,500 AFY for the same timeframe and 2,700 AFY in 2040.

A.4 SCRWA

The SCRWA WWTP serves the cities of Gilroy and Morgan Hill. Currently, SCRWA produces NPR water for Valley Water, which distributes it to users located within about five miles of the WWTP, located south of the City of Gilroy.

A.4.1 Gilroy

In 2015, SCRWA and Valley Water completed a South County Recycled Water Master Plan Update (2015 MPU) that refined the NPR market, proposed NPR expansion alternatives, and developed a 20-year CIP. A market assessment identified potential future landscape irrigation, agricultural, and municipal/industrial users, who, along with limited-term customers (e.g., construction use), would add 4,200 AFY of demand. Including 2,000 AFY used currently, the total long-term, potential demand would be 6,200 AFY.

Figure A-9 shows the current system and various user types introduced in the 2015 MPU. "In-progress users" have been permitted to use recycled water but are not yet connected or not yet taking deliveries. "Baseline users" are close to the existing alignment and have expressed interest in recycled water. "Potential users" are candidates for recycled water that could be approached in the future, following system expansion.

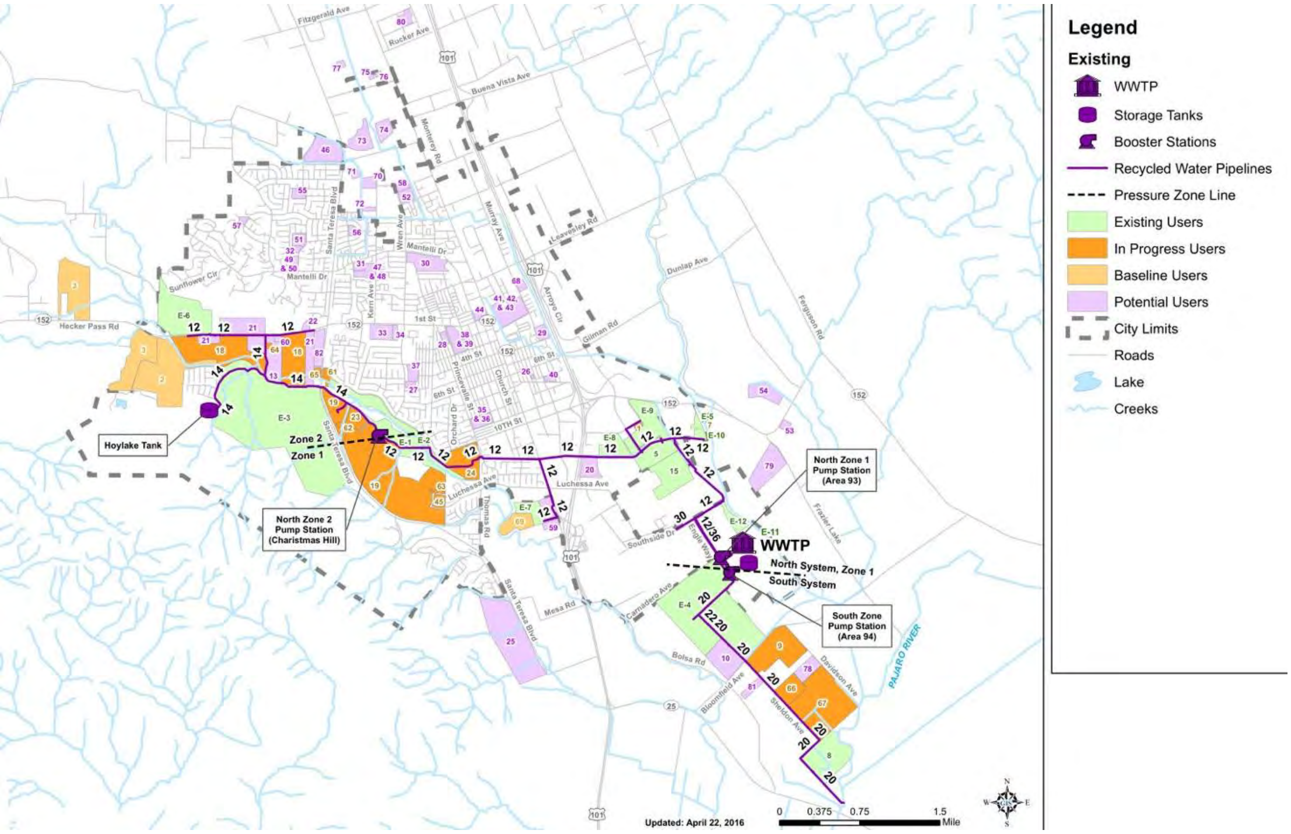

Figure A-9. Gilroy: existing RWS and potential users

Source: 2015 MPU

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The recommended CIP (shown on Figure A-10) includes new pipeline, pumping, storage, and treatment facilities. According to the 2015 MPU, it would cost approximately $98 million (2015 dollars) and add 1,200 AFY of demand, for a total of 3,700 AFY. Total long-term demand matches the City of Gilroy's 2015 UWMP.

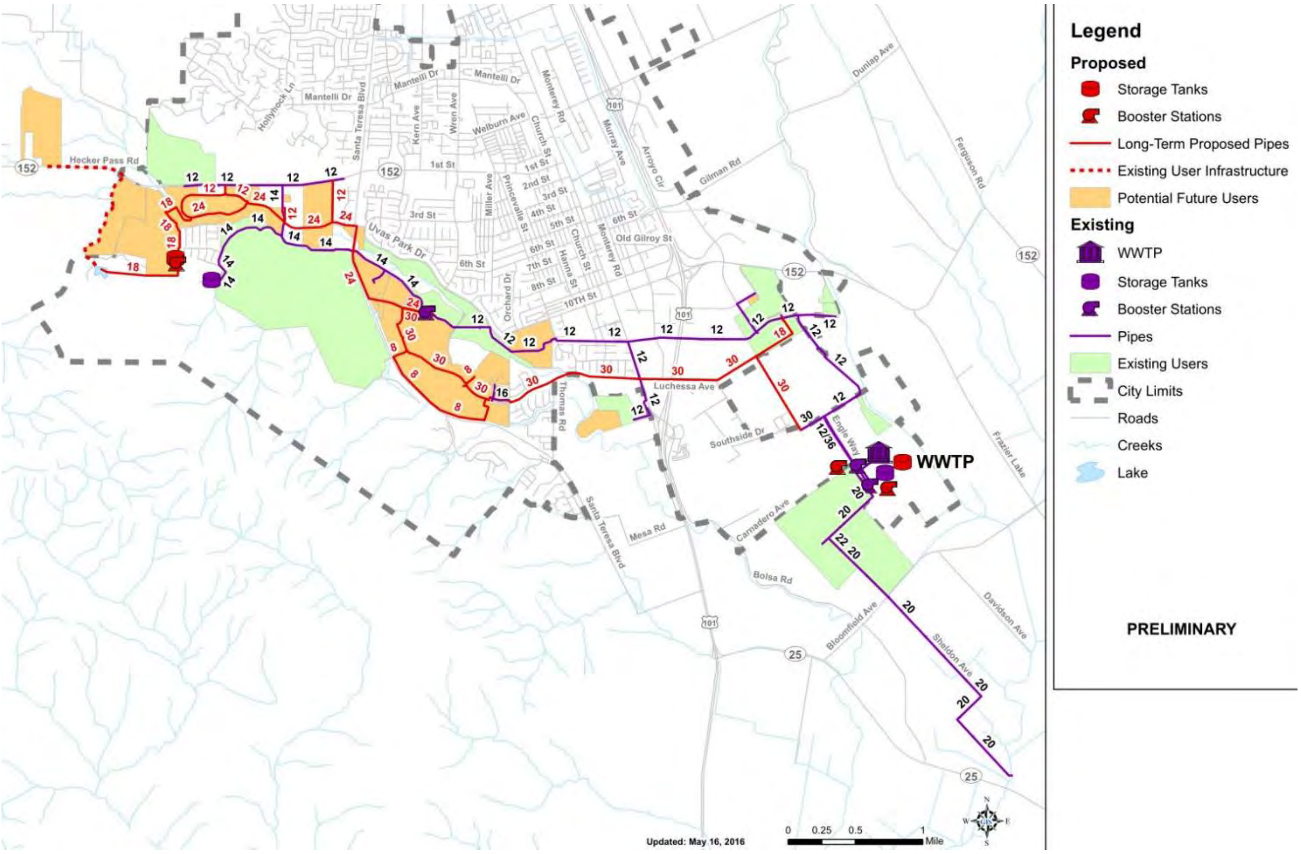

Figure A-10. Gilroy: recommended NPR system expansion

Source: Gilroy 2015 UWMP

A.4.2 Morgan Hill

Currently, the City of Morgan Hill does not receive recycled water from the SCRWA system. The 2016 RWFE examined three alternatives for extending recycled water service to Morgan Hill: two transmission main alignments (connecting Morgan Hill to Gilroy) and a satellite plant constructed in Morgan Hill. In conjunction, a Morgan Hill NPR market assessment was conducted, identifying 2,900 AFY of potential recycled water demand. Potential users are shown on Figure A-11.

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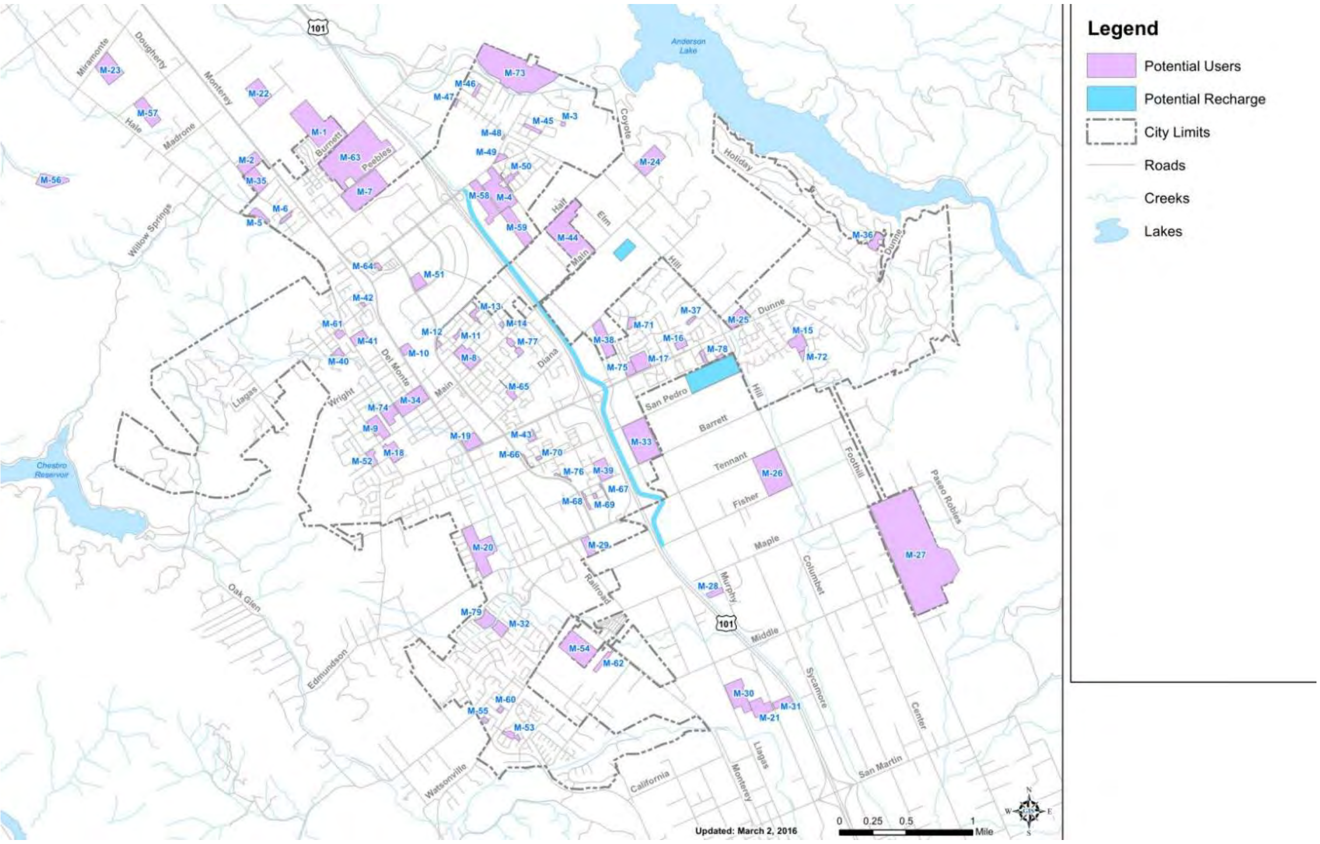

Figure A-11. Morgan Hill: potential recycled water users

Source: 2016 RWFE

Ultimately the 2016 RWFE concluded that NPR using source water from the SCRWA facility was not a feasible alternative in Morgan Hill. Additionally, a satellite plant that delivered recycled water for irrigation use would not be cost-effective. Existing customers in the city of Gilroy already use most of the available supply, and during wet months when supplies would increase, demand drops. Instead, the 2016 RWFE recommended using recycled water for GWR; a variation of this option is discussed further in Section 2.

A.5 Market Quantification Summary

Table A-2 summarizes the long-term NPR demands for each retailer, comparing projections from water retailers' 2015 UWMPs to previous retailer-specific recycled water plans (where available). The "previous study" projections include existing demand (when the plan was developed) plus any estimated demand from the plan's recommended project. Long-term UWMP demand is equal to the maximum demand projected through 2035.

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“Difference from Previous Study” compares the demand projections from the 2015 UWMPs to the previous recycled water plans. Large drops in potential demand, as with the City of Sunnyvale, could signify abandonment or major delaying of system expansion. Based on the 2015 UWMP and discussions with the City of Sunnyvale, NPR system expansion would be paused until Valley Water provides direction regarding countywide reuse efforts through the Master Plan. Smaller declines (City of Mountain View) suggest adjustments for new baseline conditions.

Demands are also subtotaled by Partner Agency and for the entire county. UWMP estimates are lower for the PA/MV RWS and Sunnyvale RWS, while 1,000 AFY of additional demand is expected for the SBWR system (fed by the SJ/SC RWF). Despite differences for individual cities, total countywide demand projections from the previous sources and 2015 UWMPs are within 2.5 percent of each other.

While previous studies and UWMPs anticipate between 32,000 and 33,000 AFY of countywide NPR demand, respectively, significant discrepancies at the retailer level mean that the most recent source should be used. Consistent with the baseline analysis, the conceptual alternatives analysis uses the 2015 UWMP projections, as they are more recent. The City of Morgan Hill’s 2016 RWFE is the only alternate source that was developed after 2015, but both sources predict zero long-term recycled water use, so nothing changed in the period between publications. Using the most recent long-term demands is critical for developing relevant conceptual alternatives. Even in concept, an alternative must pass a basic flow accounting, and reliable NPR demands are an important piece of that exercise. NPR demand projections may be updated as new information becomes available from the Partner Agencies.

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Table A-2. Long-Term NPR Demands: Baseline Source vs. 2015 UWMP

Partner Agency	Retailer	Previous Study	Long-Term NPR Demand (AFY) From Previous Study[a]	Long-Term NPR Demand (AFY) From 2015 UWMP[b]	Difference from Previous Study	Explanation of Difference
PA/MV RWS	City of Palo Alto	2008 RWFP[c]	1,740	1,750	~0	N/A
PA/MV RWS	City of Mountain View[d]	2014 RWFS	1,200	1,100	-100	Lower actual demand in 2015
PA/MV RWS subtotal[e]			3,000	2,800	-200	
Sunnyvale RWS	City of Sunnyvale	2013 FSRWE	3,100	1,400	-1,700	Expansion on hold, pending Master Plan efforts
Sunnyvale RWS	SJW (Cupertino)	2012 RWFS	0	0	0	N/A
Sunnyvale RWS	Cal Water (Cupertino)	2012 RWFS	260	260	~0	N/A
Sunnyvale RWS subtotal			3,400	1,700	-1,700	
SBWR	City of Santa Clara	2014 SMP [f]	5,200	6,500	1,300	Additional development and data center growth
SBWR	San José Municipal Water System	2014 SMP [f]	7,400	6,800	-600	Timing: 2040 demand projections from UWMP are in line with SMP
SBWR	SJW	2011 RWMP [c]	8,400	8,400	~0	N/A
SBWR	City of Milpitas	2014 SMP [f]	2,200	2,500	300	Additional development in Transit Area
SBWR subtotal			23,100	24,100	1,000	
SCRWA	City of Gilroy	2015 MPU	3,700	3,700	~0	N/A
SCRWA	City of Morgan Hill	2016 RWFE	0	0	0	N/A
SCRWA subtotal			3,700	3,700	~0	
County total[e]			33,200	32,300	-900	

a. *Equal to existing demand at time baseline source was written, plus estimated demand assuming implementation of recommended project.*

b. *Projected demand in 2035.*

c. *Baseline source did not list existing use, so average of actual recycled water deliveries in 2005 and 2010 used (data from UWMPs).*

d. *Demands outside Mountain View's water service area are excluded.*

e. *Difference due to rounding.*

f. *In the absence of a retailer-specific plan, SBWR's SMP was used.*

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Attachment B: NPR+ Multiplier Calculations

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The total effluent required to produce NPR+ ($Q_{effluent}$) is the sum of (1) secondary or tertiary treated effluent to be blended (Q_{NPR}), assumed to be one unit in this analysis, and (2) AWPF feed water ($Q_{AWPF\ feed}$) to produce enough purified water for blending. The amount of NPR+ produced ($Q_{enhanced}$) is lower than $Q_{effluent}$ because of water lost during the MF and RO processes (Q_{waste}).[5] An "NPR+ multiplier," equal to $Q_{effluent}/Q_{enhanced}$, can be calculated to determine the volume of effluent required to meet the equivalent NPR+ demand.

The purified water flow rate required for blending ($Q_{purified}$) depends on effluent flow rate and quality, purified water quality, and the target quality of NPR+. To remain consistent with the SBWR's 2014 SMP, this TM assumes that purified water has a TDS of 50 milligrams per liter (mg/L), and that the target NPR+ TDS is 500 mg/L. Equation 1 determines the purified water-to-effluent blending ratio based on these assumptions and the current effluent TDS for each Partner Agency.

$$\frac{Q_{purified}}{Q_{effluent}} = \frac{TDS_{target} - TDS_{effluent}}{TDS_{purified} - TDS_{target}} \qquad \text{(Equation 1)}$$

Where:

$Q_{purified}$ = flow rate of purified water (equal to $Q_{AWPF\ feed} - Q_{waste}$)

$Q_{effluent}$ = flow rate of effluent

TDS_{target} = NPR+ target TDS concentration, assumed to be 500 mg/L

$TDS_{effluent}$ = effluent TDS, in mg/L

$TDS_{purified}$ = purified water TDS, assumed to be 50 mg/L

Assuming one unit of Q_{NPR}, $Q_{purified}$ is equal to the blending ratio. With $Q_{purified}$ known, $Q_{enhanced}$ can be calculated as $Q_{NPR} + Q_{purified}$, and consequently, the NPR+ multiplier can be determined.

All four Partner Agencies have an NPR+ multiplier of approximately 1.1. That is, for every 1,000 AFY of NPR demand, approximately 1,100 AFY of effluent is needed to produce 1,000 AFY of NPR+. Flow balances presented in the following subsections account for improved NPR water quality at the Palo Alto RWQCP, Sunnyvale WPCP, and SJ/SC RWF. The alternatives do not contemplate changing the water quality of NPR produced at the SCRWA WWTP, so an adjustment is not necessary for that flow.

Calculations for the Sunnyvale WPCP are described here as an example, while results for the remaining Partner Agencies can be found in Table B-1. Based on the City of Sunnyvale's 2013 FSRWE, $TDS_{effluent}$ for the WPCP is assumed to be 930 mg/L. Equation 1 gives a blending ratio of 0.96, meaning that every unit of effluent must be blended with 0.96 unit of purified water to achieve a target TDS of 500 mg/L.

Using MF and RO recovery rates of 93 percent and 85 percent, respectively, it takes 1.21 units of effluent to produce 0.96 unit of purified water. Thus, after adding 1.00 unit of Sunnyvale WPCP effluent that goes directly to the NPR+ distribution system, 2.21 units of effluent produce 1.96 units of NPR+. Currently, 1.00 unit of effluent satisfies 1.00 unit of NPR demand, so assuming 1.96 units of NPR demand, the NPR+ multiplier for the Sunnyvale WPCP would be 1.13 (2.21/1.96). A process flow diagram of this example is shown on Figure B-1.

---

[5] Typically, MF backwash returns to the front of the plant so is not actually lost. Including MF backwash in the waste stream provides a conservative (high) estimate of the amount of effluent needed to produce NPR+. Flow assumptions may be refined throughout development of the Master Plan.

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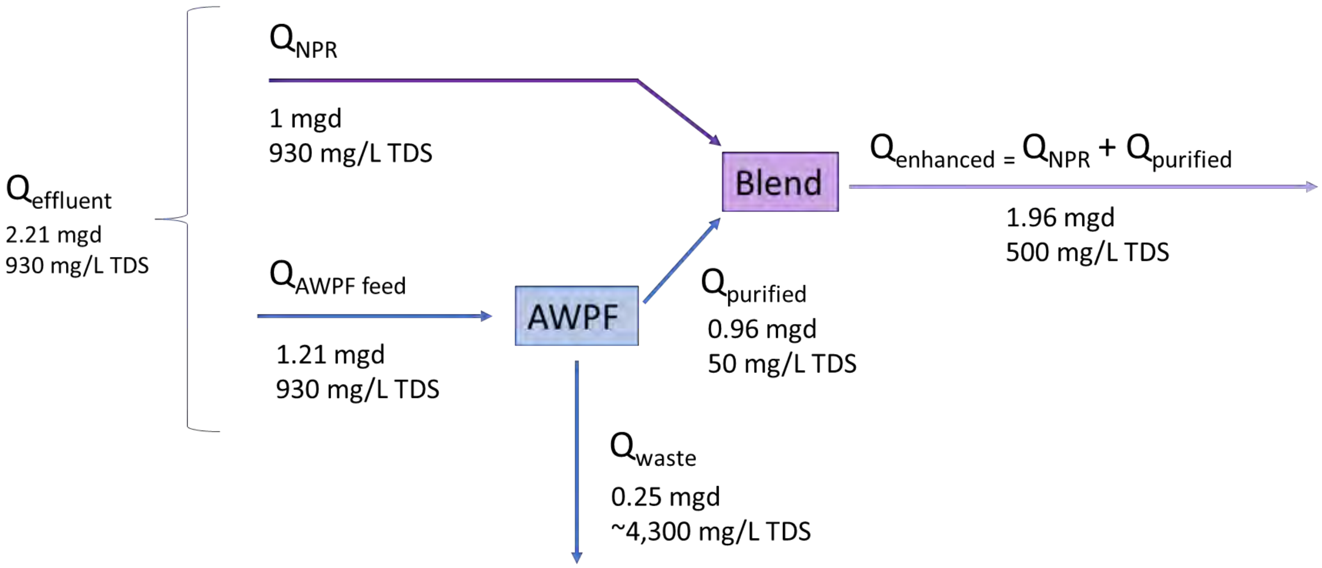


Figure B-1. NPR+ process flow diagram for Sunnyvale WPCP

Table B-1. NPR+ Blending Requirements

Producer	Effluent TDS (mg/L)	Purified Water Flow per Unit Effluent Flow	Purified Water Flow Percent	NPR+ Multiplier[a]
PA RWQCP	847[b]	0.771	43.5	1.12
Sunnyvale WPCP	930[c]	0.956	48.9	1.13
SJ/SC RWF	720[d]	0.489	32.8	1.09
SCRWA WWTP[e]	677[f]	0.392	28.2	1.08

a. *Assuming a purified water TDS of 50 mg/L, a target NPR+ TDS of 500 mg/L, and MF and RO efficiencies of 93% and 85%, respectively.*

b. *Average of TDS readings from 2015–17, as reported to California State Water Resources Control Board.*

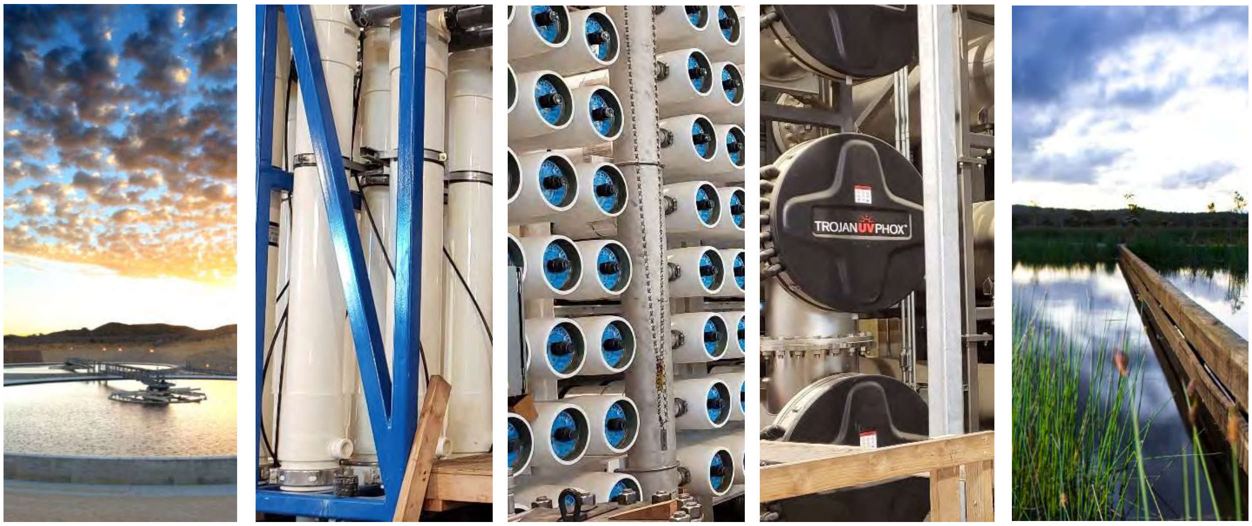
c. *Average TDS from 2007–11 per City of Sunnyvale FSRWE (June 2013).*

d. *Per SBWR's 2014 SMP, Appendix 4A.*

e. *Not proposed to upgrade to NPR+. Flow analysis below assumes SCRWA will continue producing the same quality recycled water.*

f. *12-month average as of 12/31/2017, as reported to California State Water Resources Control Board.*

Appendix G: ROC Management Reference Files



Task 6 – Evaluation of ROC Management Options Final Report

GHD | 320 Goddard Way, Suite 200 Irvine, California

GHD Project Number 11110722, September 1, 2020

Table of Contents

1. Introduction 1

1.1 Assumptions 2

2. Portfolio Description 3

2.1 Portfolio 1A/1B: Expanded SVAWPC 3

2.2 Portfolio 2A: Regional AWPF at Palo Alto 3

2.3 Portfolio 2B: Regional AWPF at Sunnyvale 4

2.4 Portfolio 4: Regional AWPFs at Palo Alto and Sunnyvale 5

2.5 Morgan Hill 6

3. Water Quality Regulations and Policies 7

4. Contaminants of Concern 10

4.1 Nutrients 10

4.2 Acute and Chronic Toxicity 10

4.3 Contaminants of Emerging Concern (CEC) 11

4.4 Metals 13

5. Methodology for Development of ROC Management Solutions 15

5.1 General List of Contaminants and Initial Screening 15

5.2 Further Screening 16

5.3 Establishing List of Contaminants to be Evaluated in this Study 18

5.4 Mass Balance Modeling 18

5.5 Development of Approach (Workshop 1: May 2017) 19

5.6 Refinement of ROC Management Strategies (Workshop 2: October, 2017) 19

5.7 Evaluation of ROC Management Options (Workshop 3: November, 2019) 20

5.8 Treatment Technologies/Technology Assessments (Workshop 4: March, 2020) 20

5.9 Blending and Discharge Using an Existing Outfall 21
5.9.1 Mass Balance Modeling 21
5.9.1.1 Annual Permeate Production Meeting NPDES Limits when Blending and Discharging at the Current Outfall 21
5.9.1.2 95th Percentile concentrations for AMEL 22
5.9.1.3 Monthly Production based on Lowest Daily Historical Flows 23

5.10 Blending and Discharge under a Joint, Modified, or Separate Permit and/or an Innovative Permitting Strategy 23

5.10.1 Anti-Backsliding 23
5.10.2 Dilution Credit 24
5.11 Enhanced Mixing Outfall 24
5.12 Discharging to a Deep Water Outfall 25
5.13 Evaporation Ponds 25
6. ROC Management Options 26
6.1 Portfolio 1 27
6.1.1 Portfolio 1: Blending and Discharging “Outside the Fence Line” 27
6.1.1.1 CAPEX and LCC 28
6.1.2 Portfolio 1: Enhanced Mixing Outfall 28
6.1.2.1 Hydrodynamic Modeling 28
6.1.2.2 CAPEX and LLC 29
6.2 Portfolio 2A 30
6.2.1 Portfolio 2A: Blending and Discharging 30
6.2.1.1 CAPEX and LCC 31
6.2.2 Portfolio 2A: Enhanced Mixing Outfall 31
6.2.2.1 Hydrodynamic Modeling 32
6.2.2.2 CAPEX and LCC 33
6.2.3 Portfolio 2A: Deep Water Discharge 33
6.2.3.1 CAPEX and LCC 34
6.3 Portfolio 2B 35
6.3.1 Portfolio 2B: Enhanced Mixing Outfall 35
6.3.1.1 Hydrodynamic Modeling 35
6.3.1.2 CAPEX and LCC 36
6.4 Portfolio 4 37
6.4.1 Portfolio 4: Blending and Discharging 37
6.4.1.1 CAPEX and LCC 38
6.4.2 Portfolio 4: Enhanced Mixing Outfall 38
6.4.2.1 Hydrodynamic Modeling 39
6.4.2.2 CAPEX and LCC 40
6.4.3 Portfolio 4: Deep Water Discharge 40
6.4.3.1 Hydrodynamic Modeling 42
6.4.3.2 CAPEX and LCC 42
6.5 Morgan Hill 42
6.5.1 Morgan Hill: Evaporation Ponds 43
6.5.1.1 CAPEX and LCC 43
7. Conclusions/Summary 45
7.1 Summary of Options 45
7.2 Recommendations for Next Steps for ROC Management 45

Figure Index

Figure 2.1: Portfolio 1A/1B 3

Figure 2.2: Portfolio 2A........ 4

Figure 2.3: Portfolio 2B........ 5

Figure 2.4: Portfolio 4 6

Figure 6.1: Example of Hydrodynamic Results for Dilution Factors near SJ-SC RWF........ 29

Figure 6.2: Example of Hydrodynamic Results for Dilution Factors near PA RWQCP........ 33

Figure 6.3: Example of Hydrodynamic Results for Dilution Factors near Sunnyvale WPCP........ 36

Table Index

Table 5.1 Initial Screening, Contaminants that Exceed the Water Quality Criterion without Blending (Using MECs reported in POTW NPDES Permits)........ 16

Table 5.2: ROC Management Alternatives 19

Table 5.3: Permeate Production vs Target Permeate Production 22

Table 5.4: Permeate Production vs Target Permeate Production (95%-ile Concentration for AMEL and Lower Bound Flows)........ 22

Table 5.5: Minimum Daily Permeate Production (Lowest Observed Daily Flows and 95%-ile Concentrations) 23

Table 5.6: Estimated Minimum Dilution Credits Needed for Portfolios to Meet NPDES Permits (Lower Bound Flows)........ 24

Table 6.1 Preliminary Design for Portfolio 1: Blending after the Effluent Weir........ 27

Table 6.2 CAPEX and Life-Cycle Costs for Portfolio 1: Blending after the Effluent Weir 28

Table 6.3 Preliminary Design for Portfolio 1: Extension to Coyote Creek........ 28

Table 6.4 CAPEX and Life-Cycle Costs for Portfolio 1: Extension to Coyote Creek 30

Table 6.5 Preliminary Design for Portfolio 2A: Blending with Palo Alto Effluent........ 30

Table 6.6 CAPEX and Life-Cycle Costs for Portfolio 2A: Blending with Palo Alto Effluent........ 31

Table 6.7 Preliminary Design for Portfolio 2A: Extension into San Francisco Bay 32

Table 6.8 CAPEX and Life-Cycle Costs for Portfolio 2A: Extension into San Francisco Bay........ 33

Table 6.9 Preliminary Design for Portfolio 2A: Deep Water Discharge........ 34

Table 6.10 CAPEX and Life-Cycle Costs for Portfolio 2A: Deep Water Discharge 34

Table 6.11 Preliminary Design for Portfolio 2B: Extension to Guadalupe Slough 35
Table 6.12 CAPEX and Life-Cycle Costs for Portfolio 2B: Extension to Guadalupe Slough 36
Table 6.13 Preliminary Design for Portfolio 4: Blending with Palo Alto Effluent 37
Table 6.14 Preliminary Design for Portfolio 4: Extension to Guadalupe Slough at Sunnyvale............ 38
Table 6.15 CAPEX and Life-Cycle Costs for Portfolio 4: Blending with Palo Alto Effluent and Extension to Guadalupe Slough at Sunnyvale 38
Table 6.16 Preliminary Design for Portfolio 4: Extension into San Francisco Bay (Palo Alto)............. 39
Table 6.17 Preliminary Design for Portfolio 4: Extension to Guadalupe Slough (Sunnyvale) 39
Table 6.18 CAPEX and Life-Cycle Costs for Portfolio 4: Extension into San Francisco Bay at Palo Alto and Extension to Guadalupe Slough at Sunnyvale 40
Table 6.19 Preliminary Design for Portfolio 4 Deep Water Discharge (Palo Alto) 41
Table 6.20 Preliminary Design for Portfolio 4 Extension to Guadalupe Slough (Sunnyvale) 42
Table 6.21 CAPEX and Life-Cycle Costs for Portfolio 4: Deep Water Discharge (Palo Alto) and Extension to Guadalupe Slough at Sunnyvale 42
Table 6.22 Preliminary Design for Morgan Hill: Evaporation Pond in Gilroy....................................... 43
Table 6.23 CAPEX and Life-Cycle Costs for Morgan Hill: Evaporation Pond in Gilroy 43
Table 7.1 Summary of CAPEX and LCC Estimates for ROC Management Options........................... 45

Appendix Index

Appendix I Proposed Pipeline Alignments for ROC Management Options
Appendix II CAPEX Estimates for ROC Management Options
Appendix III 30 and 100 Year Life Cycle Costs for ROC Management Options

Abbreviations

The following abbreviations are used in this report.

AACE – Association for the Advancement of Cost Engineering

AFD – Acre Feet per Day

AFY – Acre Feet per Year

AMEL – Average Monthly Effluent Limit

AWPF – Advanced Water Purification Facilities

BACWA – Bay Area Clean Water Agencies

Basin Plan - San Francisco Bay Basin Water Quality Control Plan

CEC – Contaminants of Emerging Concern

CEQA – California Environmental Quality Act

CIWQS – California Integrated Water Quality System Project

CWA – Clean Water Act

CWRMP – Countywide Water Reuse Master Plan

D7 – Countywide Water Reuse Master Plan Deliverable Report Number Seven

EBCT – Empty Bed Contact Time

EBDA – East Bay Dischargers Authority (discharge)

EDTA – Ethylene Diamine Tetra-Acetic Acid

GAC – Granular Activated Carbon

HDPE – High Density Polyethylene

ISWEBE Plan - Water Quality Control Plan for Inland Surface Waters Enclosed Bays and Estuaries of California

LCC – Life-Cycle Costs

LSB – Lower South San Francisco Bay

MCA – Multi Criteria Analysis

MDEL – Maximum Daily Effluent Limit

MEC – Maximum Effluent Concentration

MGD – Million Gallons per Day

NOEC – No Observed Effect Concentration

NP – Nonylphenols

NPE – Nonylphenol Ethoxylates

NPDES – National Pollutant Discharge Elimination System

PFAS – Polyfluoroalkyl Substances

PFOA – Perfluorooctanoic Acid

PFOS – Perfluorooctane Sulfonate

PNEC – Predicted No Effect Concentration

POTW – Publicly Owned Treatment Works (i.e. Wastewater Treatment Plant)

PPL – United States Environmental Protection Agency Priority Pollutants List

RMP – Regional Monitoring Program for Water Quality in San Francisco Bay

RPA – Reasonable Potential Analysis

RO – Reverse Osmosis

ROC – Reverse Osmosis Concentrate

RWQCP – Palo Alto Regional Water Quality Control Plant

SCVWD – Santa Clara Valley Water District

SFEI – San Francisco Estuary Institute

SJ-SC RWF – San Jose-Santa Clara Regional Wastewater Facility

State Water Board – State Water Resources Control Board

SVAWPC – Silicon Valley Advanced Water Purification Center

SVCW – Silicon Valley Clean Water

TMDL – Total Maximum Daily Load

UF/MF – Ultrafiltration/Microfiltration

USEPA – United States Environmental Protection Agency

USGS – U.S. Geological Survey

Valley Water – Formerly known as Santa Clara Valley Water District

Water Board – San Francisco Bay Regional Water Quality Control Board

WDR – Waste Discharge Requirements

WPCP – Sunnyvale Water Pollution Control Plant

WQC – Water Quality Criterion

WTP – Water Treatment Plant

1. Introduction

Climate change, population increase, and frequent drought conditions have made surface and groundwater supplies increasingly unreliable. To meet current and anticipated water demand, Valley Water, formerly known as Santa Clara Valley Water District (SCVWD), seeks to enhance the reliability of its water supply through increased production of potable recycled water.

Valley Water has set a goal that 10% of its water demand be met by recycled water supplies by 2028. It plans to meet this goal with the introduction of Advanced Water Purification Facilities (AWPF) that will use advanced treatment processes to treat final effluent from the wastewater treatment facilities of partner agencies to produce 28,000 acre-feet-per-year (AFY) for potable reuse.

The partner agencies include the City of Palo Alto, the City of Sunnyvale, South Bay Water Recycling, and South County Regional Wastewater Authority.

GHD’s role in this project is to incorporate stakeholder feedback to assess and recommend reverse osmosis concentrate (ROC) management options for each AWPF portfolio under consideration. This will assist the stakeholders in determining the best option for locating the AWPFs.

There are currently four portfolios being assessed:

- Portfolio 1: The Regional 24 MGD AWPF is located at the San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF).
- Portfolio 2A: The Regional 24 MGD AWPF is located at the former Los Altos treatment plant site.
- Portfolio 2B: The Regional 24 MGD AWPF is located at Sunnyvale Water Pollution Control Plant (WPCP).
- Portfolio 4: Two Regional AWPF’s with a combined target capacity of 24 MGD are located at Sunnyvale WPCP and at the former Los Altos treatment plant site.

All portfolios also include a 2 MGD AWPF in South County tentatively located in Morgan Hill.

With the exception of the ROC produced at the AWPF in South County, all ROC management options must ensure compliance with surface water discharge limitations specified by the San Francisco Bay Regional Water Quality Control Board (Water Board) to comply with the objectives and policies specified in the “San Francisco Bay Basin Water Quality Control Plan” (Basin Plan).

Our approach to developing a list of problematic contaminants was first to evaluate the data and multiply the highest concentration of each constituent by 6.7 to reflect 100 percent removal and 85 percent recovery by the Reverse Osmosis (RO) process, eliminating those contaminants that did not exceed the limits even under these conditions. Secondly, we applied a treatment model to the contaminants using appropriate removal efficiencies for each unit process, thereby eliminating more of them. We then updated our data set with more recent data and applied other factors such as attenuation to form the final list of contaminants.

A list of management solutions was developed from suggested possible options which were evaluated using Multi Criteria Analysis (MCA) to eliminate those which were fatally flawed.

The list of potential ROC management options includes:

- ROC treatment for removal of contaminants
- Blending with residual wastewater effluent and discharge at existing outfalls in San Francisco Bay
- Discharge from an outfall in San Francisco Bay in an area of enhanced mixing
- Discharge from a deep water outfall in San Francisco Bay north of Dumbarton Bridge
- Disposal by deep well injection

The various ROC management options have been evaluated by engineering judgement based on their ability to comply with discharge limitations and their relative costs. The purpose of this report is to summarize the previous works done on this project, provide the most feasible management strategies for each portfolio, and propose some recommended next steps.

1.1 Assumptions

For the purpose of consistency through this document and other documents produced as part of the SCVWD ROC Management Project, the flows considered during design and analysis are outlined and defined as follows:

- All flows considered in this study have been adopted from the Countywide Water Reuse Master Plan (CWRMP) per their draft deliverable report number seven (D7) document dated 10/24/2019 to be consistent with their designs with the exception of the Palo Alto minimum historical flow scenario, presented in Table 5.5.
- Final effluent (or effluent) – flow available for an AWPF feed (used to indicate “secondary” or “tertiary” effluent from the respective wastewater treatment facility).
- Blending – combining final effluent with ROC prior to discharging from an outfall.
- Final ROC effluent blend – flow available for an AWPF stream used to blend (at an outfall).

  The level of treatment for AWPF feedwater from each facility is as follows:

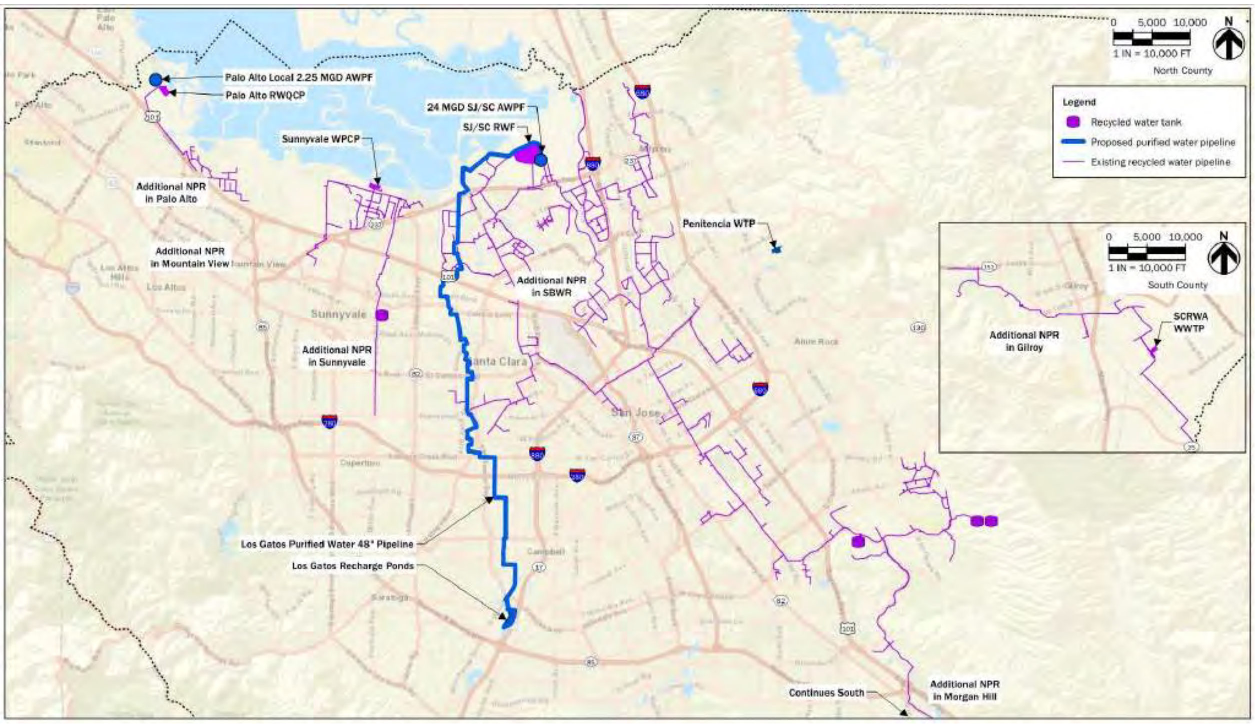
  - SJ-SC RWF – fully nitrified, tertiary treated effluent (existing Silicon Valley Advanced Water Purification Center (SVAWPC) will continue to receive secondary treated effluent)
  - Palo Alto Regional Water Quality Control Plant (RWQCP) – fully nitrified, tertiary treated effluent
  - Sunnyvale WPCP – fully nitrified, tertiary treated effluent. Sunnyvale is currently constructing an engineered nitrification system.
- AWPF permeate (or permeate) – anticipated permeate production capacity for each AWPF.
- AWPF feed – feed to an AWPF from available final effluent flow.
- AWPF ROC – main flow of concern requiring management, and basis of this study.
- Total discharge to outfall – sum of residual final effluent and ROC (in cases where ROC is blended with final effluent).

An additional assumption is that for the California Environmental Quality Act (CEQA) process, Valley Water has indicated that ROC Management improvements will be evaluated in a Program EIR adopted for the AWPF project.

2. Portfolio Description

2.1 Portfolio 1A/1B: Expanded SVAWPC

For the purposes of this study, Portfolios 1A and 1B will be evaluated as a single Portfolio since the ROC quantities and locations are the same for both. This Portfolio includes an expanded SVAWPC at San Jose, which will consist of a new AWPF with a production capacity of 24 MGD in addition to the existing 8 MGD SVAWPC. The AWPF would produce up to 4.24 MGD of ROC. Figure 2.1 shows a schematic of the Portfolio, slightly modified to include both Portfolio 1A and 1B from the CWRMP. (Facilities shown in blue are the new facilities for this Portfolio.)



*This figure shows the potable reuse overview for Portfolio 1A. In Portfolio 1B, the purified water would go to Penitencia Water Treatment Plant (WTP)

Figure 2.1: Portfolio 1A/1B[1]

2.2 Portfolio 2A: Regional AWPF at Palo Alto

This portfolio consists of a Regional AWPF at Palo Alto receiving final effluent feed from the Palo Alto RWQCP supplemented with final effluent feed from the Sunnyvale WPCP. The engineered nitrification process is currently being delayed but we assumed for the purposes of this study that full nitrification was achieved. The AWPF would produce up to 24 MGD of permeate for PR, and up to 4.24 MGD of ROC. Figure 2.2 shows a schematic of the Portfolio.

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[1] Adapted from CWRMP D7 dated 10/24/2019

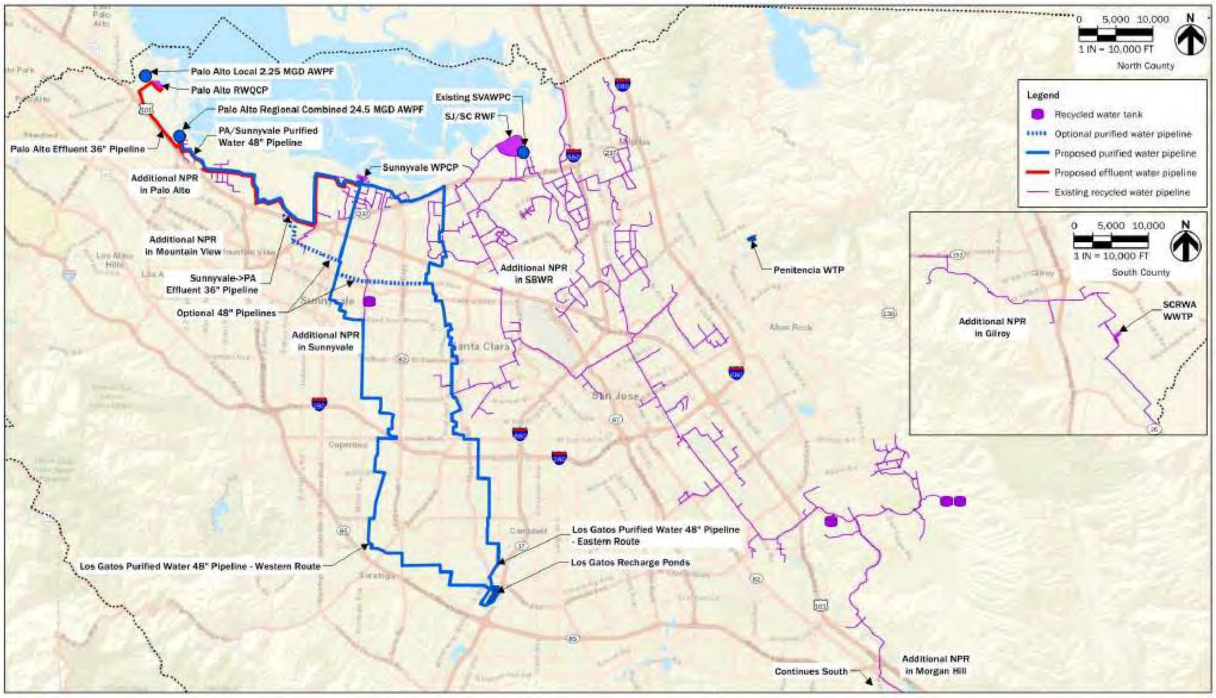
Palo Alto Local 2.25 MGD AWPF
Palo Alto RWQCP
Palo Alto Regional Combined 24.5 MGD AWPF
PA/Sunnyvale Purified Water 48" Pipeline
Palo Alto Effluent 36" Pipeline
Additional NPR in Palo Alto
Additional NPR in Mountain View
Sunnyvale->PA Effluent 36" Pipeline
Optional 48" Pipelines
Additional NPR in Sunnyvale
Sunnyvale WPCP
Existing SVAWPC
SJ/SC RWF
Additional NPR in SBWR
Penitencia WTP
Los Gatos Purified Water 48" Pipeline - Western Route
Los Gatos Purified Water 48" Pipeline - Eastern Route
Los Gatos Recharge Ponds
Continues South
Additional NPR in Morgan Hill
0 5,000 10,000
N
1 IN = 10,000 FT
North County
Legend
Recycled water tank
Optional purified water pipeline
Proposed purified water pipeline
Proposed effluent water pipeline
Existing recycled water pipeline
0 5,000 10,000
N
1 IN = 10,000 FT
South County
Additional NPR in Gilroy
SCRWA WWTP

Figure 2.2: Portfolio 2A[2]

2.3 Portfolio 2B: Regional AWPF at Sunnyvale

This portfolio is similar to Portfolio 2A, with the exception that the Regional AWPF is located at Sunnyvale. The Regional AWPF would receive final effluent feed from Sunnyvale WPCP supplemented with final effluent feed from Palo Alto RWQCP. The AWPF would produce up to 24 MGD of permeate for PR, and up to 4.24 MGD of ROC. Portfolio 2B is shown in Figure 2.3.

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[2] Adapted from CWRMP D7 dated 10/24/2019

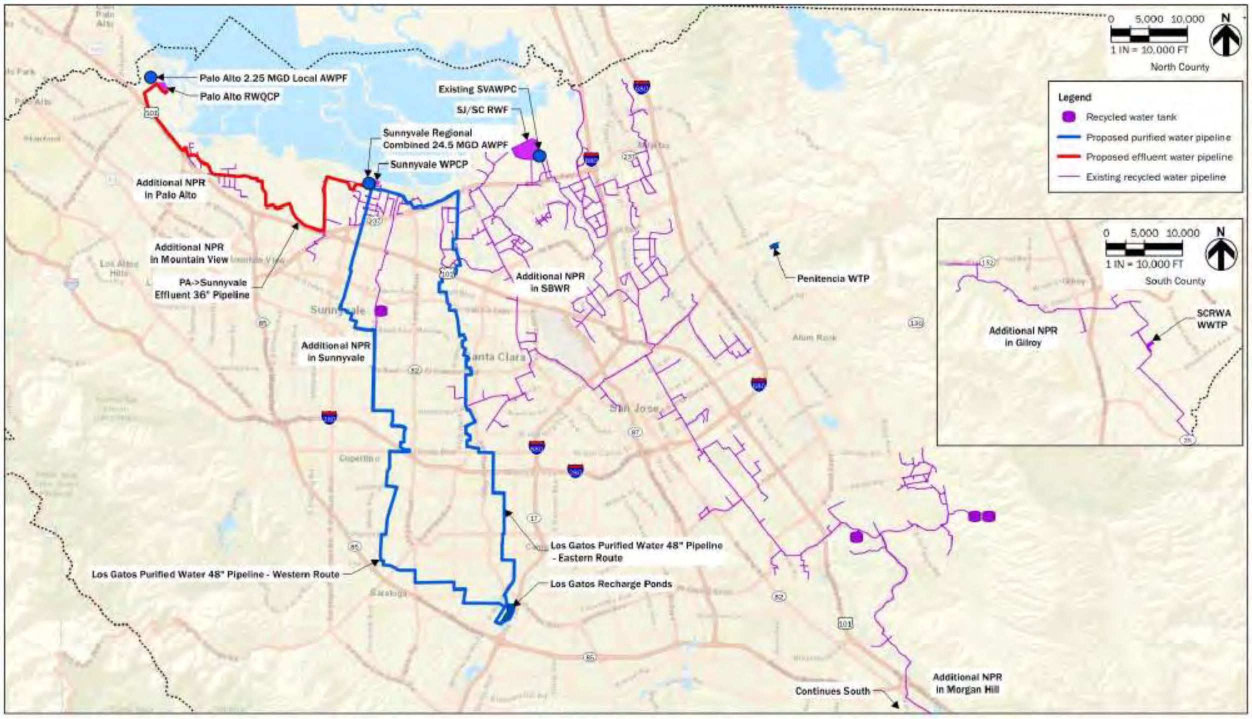
Palo Alto 2.25 MGD Local AWPF
Palo Alto RWQCP
Existing SVAWPC
SJ/SC RWF
Sunnyvale Regional Combined 24.5 MGD AWPF
Sunnyvale WPCP
Additional NPR in Palo Alto
Additional NPR in Mountain View
PA->Sunnyvale Effluent 36" Pipeline
Additional NPR in SBWR
Additional NPR in Sunnyvale
Penitencia WTP
Los Gatos Purified Water 48" Pipeline - Eastern Route
Los Gatos Purified Water 48" Pipeline - Western Route
Los Gatos Recharge Ponds
Continues South
Additional NPR in Morgan Hill
0 5,000 10,000
1 IN = 10,000 FT
North County
N
Legend
Recycled water tank
Proposed purified water pipeline
Proposed effluent water pipeline
Existing recycled water pipeline
0 5,000 10,000
1 IN = 10,000 FT
South County
N
Additional NPR in Gilroy
SCRWA WWTP

Figure 2.3: Portfolio 2B[3]

2.4 Portfolio 4: Regional AWPFs at Palo Alto and Sunnyvale

This portfolio consists of separate Regional AWPFs at Palo Alto and Sunnyvale with a production capacity of 14.0 and 10.5 MGD at Palo Alto and Sunnyvale, respectively. Discharges for this portfolio are similar to those in Portfolios 2A and 2B, but with two smaller maximum flows of ROC (2.47 MGD at Palo Alto and 1.76 MGD at Sunnyvale) to manage, and no transport of final effluent between the plants. Portfolio 4 is shown in Figure 2.4.

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[3] Adapted from CWRMP D7 dated 10/24/2019

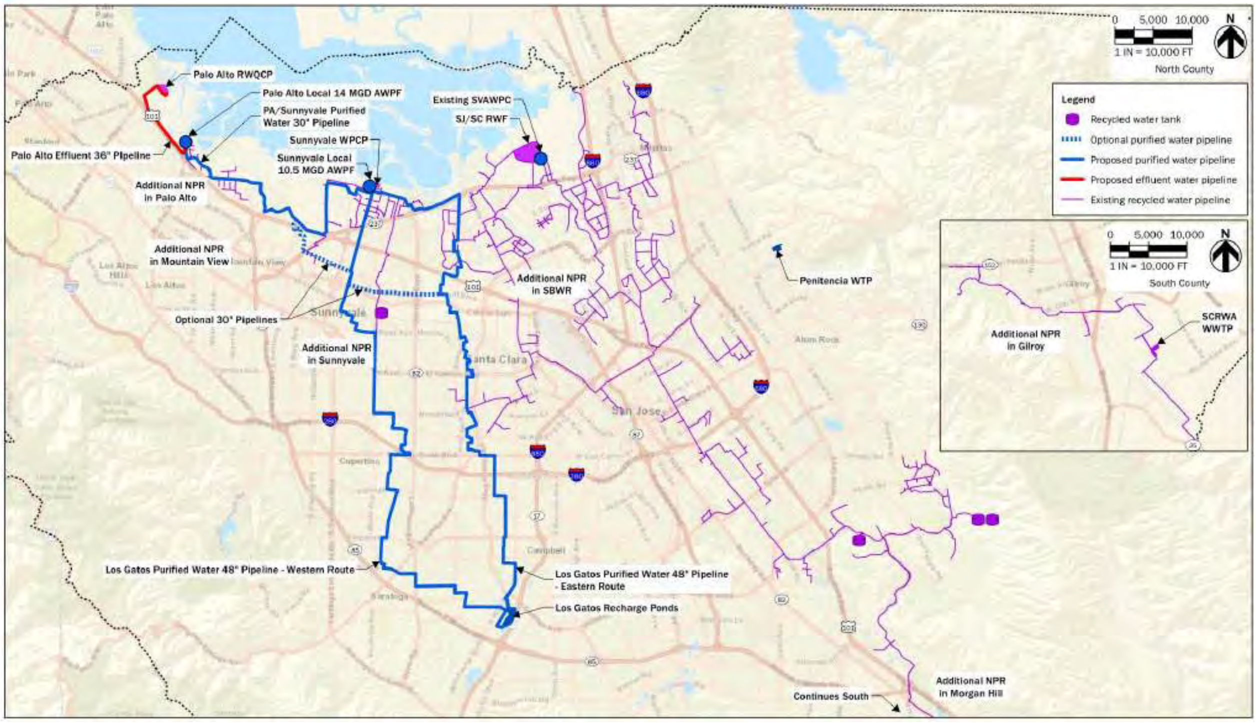
Palo Alto RWQCP
Palo Alto Local 14 MGD AWPF
PA/Sunnyvale Purified Water 30" Pipeline
Palo Alto Effluent 36" Pipeline
Sunnyvale WPCP
Sunnyvale Local 10.5 MGD AWPF
Existing SVAWPC
SJ/SC RWF
Additional NPR in Palo Alto
Additional NPR in Mountain View
Optional 30" Pipelines
Additional NPR in Sunnyvale
Additional NPR in SBWR
Penitencia WTP
Los Gatos Purified Water 48" Pipeline - Western Route
Los Gatos Purified Water 48" Pipeline - Eastern Route
Los Gatos Recharge Ponds
Continues South
Additional NPR in Morgan Hill
0 5,000 10,000
1 IN = 10,000 FT
N
North County
Legend
Recycled water tank
Optional purified water pipeline
Proposed purified water pipeline
Proposed effluent water pipeline
Existing recycled water pipeline
South County
Additional NPR in Gilroy
SCRWA WWTP

Figure 2.4: Portfolio 4[4]

2.5 Morgan Hill

All portfolios will include an AWPF located at Morgan Hill with influent from the South County Regional Wastewater Authority in Gilroy.

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[4] Adapted from CWRMP D7 dated 10/24/2019

3. Water Quality Regulations and Policies

The San Francisco Bay is a Water of the U.S. and a Water of the State. As such, the water quality regulations and policies that affect waste discharges to the San Francisco Bay are promulgated by the Water Board, the State Water Resources Control Board (State Water Board), and the USEPA. The Water Board has primary authority to issue discharge permits and evaluate compliance with permit provisions. The USEPA may comment on draft permits or object to issuance of a permit or its specific provisions. In addition, the USEPA may review monitoring data, can provide technical assistance/guidance to the Water Board, and has authority to perform facility inspections. The State Water Board conducts permit appeals, approves all changes to Water Quality Control Plans, and provides enforcement assistance. The key regulatory and policy mechanisms that dictate approval of Publicly Owned Treatment Works (POTW) effluent and ROC discharge to San Francisco Bay are described in the following sections.

3.1 Water Quality Control Plans

The Water Board maintains and implements the Basin Plan. The Basin Plan identifies beneficial uses of receiving waters, establishes water quality objectives to protect the beneficial uses, defines implementation procedures, and incorporates all applicable state/federal regulations and policies. The State Water Board maintains the “Water Quality Control Plan for Inland Surface Waters Enclosed Bays and Estuaries of California” (ISWEBE Plan). The ISWEBE Plan includes policies and procedures that are applicable to approving discharges to the San Francisco Bay estuary and supersedes any conflicting provisions in the Basin Plan. The Basin Plan and ISWEBE Plan are the master water quality control documents and dictate provisions that are incorporated into National Pollutant Discharge Elimination System (NPDES) permits and Waste Discharge Requirements (WDR).

A few major changes to the Water Quality Control Plans are underway that will affect permitting for ROC discharges. The Basin Plan currently includes concentration-based water quality criteria for selenium that were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule[5]. Based on that criteria, the South Bay is listed as “impaired” for selenium in the 2014/2016 California’s Clean Water Act Section 303(d) List and 305(b) Integrated Report[6]. Water column data don’t actually exceed the concentration-based criteria, but the State Water Board and the USEPA don’t believe the criteria is sufficiently protective for sensitive fish species. As a result, the South Bay is considered impaired until the impairment is addressed through either adoption of a Total Maximum Daily Load (TMDL) or a site specific objective. The Water Board is considering a site-specific objective for selenium (based on fish tissue concentrations) that will be developed in parallel with project development and NPDES permitting.

The State Water Board is developing Statewide Toxicity Provisions that will be included in the ISWEBE Plan. Revised Statewide Toxicity Provisions are expected in July 2020 with adoption prior to the end of 2020. These provisions will supersede the toxicity provisions of the Basin Plan and will be incorporated into NPDES permits during initial adoption or reissuance. The major implications for San Francisco Bay NPDES permits will be the inclusion of numeric chronic toxicity limits, more frequent monitoring for chronic toxicity, evaluation of compliance using the instream waste concentration (i.e., actual dilution in the receiving water), and elimination of acute toxicity limits and associated monitoring requirements.

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[5] 40 CFR 131.36

[6] https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml

3.2 Science Advisory Panels, Investigative Orders, Regional Monitoring Programs

To develop water quality policies and establish new water quality objectives, the State Water Board provides funding for Science Advisory Panels (to provide technical expertise) and issues Investigative Orders (to obtain operational information and data). A Science Advisory Panel (consisting of toxicologists, epidemiologists, biochemists, and engineers) was convened in 2009 to recommend monitoring strategies for contaminants of emerging concern (CEC) in aquatic ecosystems[7]. The panel developed a risk-based screening framework to identify a list of CEC for initial monitoring and an adaptive, phased monitoring approach.

The State Water Board is implementing the recommended CEC monitoring approach through pilot programs and regional monitoring efforts across the state. San Francisco Bay monitoring is conducted by the San Francisco Estuary Institute (SFEI) under the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). The RMP is funded by NPDES permittees and the Water Board. Under the RMP, SFEI collects receiving water, sediment, and aquatic organism data to evaluate toxicity and determine concentrations of CEC, nutrients, and Priority Pollutants. Information obtained from the RMP is used by the Water Board to evaluate compliance with narrative receiving water quality objectives and, if necessary, develop numeric effluent limits in NPDES permits.

The State Water Board is issuing Investigative Orders (based on CWC 13267 authority) to obtain information on the occurrence and levels of per- and polyfluoroalkyl substances (PFAS) at various high-impact sites. An Investigative Order for data related to PFAS occurrence in POTW effluent and brine is expected in the summer of 2020. The results may be used to develop water quality objectives to protect the designated beneficial uses of the receiving water.

3.3 Facility-Specific NPDES Permits

Requirements for treatment plant operation and quality of treated wastewater discharged to the San Francisco Bay are specified through facility-specific NPDES permits issued by the Water Board. The NPDES permits include discharge prohibitions, effluent limitations, receiving water limitations, special study provisions, and monitoring/reporting requirements. The discharge prohibitions ensure proper treatment, treatment at the facility's design capacity, discharge at approved outfalls, and minimum initial dilution. Technology-based effluent limits are specified for constituents that are managed by treatment plant design and proper operation (i.e., BOD, TSS, pH, oil and grease, turbidity, bacteria, chlorine residual). Water quality-based effluent limits are specified for constituents that demonstrate "reasonable potential" to exceed water quality objectives and criteria (i.e., Priority Pollutants, ammonia) in the receiving water. Numeric effluent limits for acute toxicity are currently required per the Basin Plan. Chronic toxicity limits are not currently required unless monitoring results demonstrate reasonable potential to exceed the narrative chronic toxicity objective. Receiving water objectives are specified in the Basin Plan and are incorporated into the NPDES permit to prevent nuisance conditions (e.g., color, minimum dissolved oxygen, sedimentation, turbidity). Influent and effluent monitoring requirements are specified to review treatment plant performance, determine compliance with effluent limits, and to evaluate reasonable potential during permit reissuance. Participation in the RMP is required to comply with receiving water monitoring requirements.

Each treatment plant and its associated outfall(s) has a facility-specific NPDES permit to govern operation and discharge. Current NPDES permits will have to be modified to accept ROC for blending with treated effluent and discharge at an existing outfall. A new NPDES permit will have to be issued if ROC will be discharged under a separate permit or at a new outfall.

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[7] https://www.waterboards.ca.gov/water_issues/programs/swamp/cec_aquatic/

3.4 Watershed-Based NPDES Permits

The Water Board has adopted two watershed-based NPDES permits for discharges to the San Francisco Bay. The Mercury and PCBs Watershed Permit (NPDES No. CA0038849) includes WDRs for municipal and industrial wastewater dischargers to implement TMDL wasteload allocations. The permit includes effluent limits for mercury and PCBs (concentration-based and mass-based), triggers for additional monitoring, action plans in response to trigger exceedances, source control requirements, participation in a risk reduction program, and monitoring/reporting requirements. For ROC derived from municipal wastewater effluent, the wasteload allocations in the permit will have to be modified to address the transfer of mercury and PCBs from wastewater effluent to ROC.

The Nutrient Watershed Permit (NPDES No. CA0038873) includes WDRs for municipal wastewater dischargers to implement the San Francisco Bay Nutrient Management Strategy. The San Francisco Bay Nutrient Management Strategy is a collaborative program undertaken by the Water Board, the USEPA, the Bay Area Clean Water Agencies (BACWA), and other stakeholders to understand nutrient loadings from municipal POTW and their possible impacts to beneficial uses of the Bay. The Nutrient Management Strategy Science Plan is implemented by SFEI through scientific studies and modeling to define conditions of impairment, risks of impairment under future scenarios, responses of San Francisco Bay habitats to nutrient loads, contributions of individual nutrient sources, and actions that may be needed to mitigate or prevent impairments. The 2019 Nutrient Watershed Permit includes requirements for permittees to participate in regional evaluations of potential nutrient reductions (by increasing water recycling and installing natural systems), make financial contributions for receiving water monitoring and Science Plan implementation, and conduct influent and effluent monitoring. The 2024 Nutrient Watershed Permit is expected to include load caps for each subembayment and regional planning requirements to minimize the potential for municipal wastewater treatment plants to cause degradation. The regional plans will include options to conduct treatment upgrades, expand recycled water programs, implement nature-based adaptation measures (i.e., protection from sea level rise to improve Bay resilience to nutrients), and establish a nutrient trading framework within the subembayments. Establishment of a nutrient trading program will facilitate transfer of nutrient credits between dischargers and allow service area growth if nutrients can be more effectively removed at a newly constructed AWPF. Based on discussions between BACWA and the Water Board, nitrogen load caps will be determined from 2014 to 2017 wastewater treatment plant performance records (maximum dry season average, total inorganic nitrogen) with a 15% buffer to account for population growth. AWPF operation and increased recycling for potable reuse will facilitate compliance with load caps in the South San Francisco Bay.

4. Contaminants of Concern

There are several suites of contaminants of concern for each ROC Management option. Contaminants relevant to this analysis include nutrients, toxicity, CEC and metals.

4.1 Nutrients

Nutrient removal provisions were developed for each portfolio, ahead of anticipated effluent limits for total inorganic nitrogen in the Nutrient Watershed Permit. The limits have not been developed to-date, but they are expected to be based on mass load, not concentration. On that basis, the ROC management options of blending, application of a dilution credit, or a deep-water outfall would not reduce nutrient mass loads. It is possible that the POTW will be capable of meeting the nutrient loading requirements with modifications, but at a significant cost. Since the nutrient loading from each POTW will not change with the addition of AWPFs, ROC management may prove to be beneficial to the POTW in the sense that a concentrated, small flow stream may be easier to treat than a larger, dilute one.

4.2 Acute and Chronic Toxicity

As described in the proposed Statewide Toxicity Provisions, "Aquatic toxicity is the adverse response of aquatic organisms from exposure to chemical or physical agents, and/or their synergistic effects in effluent or receiving water. Acute aquatic toxicity refers to adverse response (typically lethality) from a short-term exposure. Chronic aquatic toxicity generally refers to a longer exposure duration and measures of both lethal and sub-lethal adverse response."[8] Acute and chronic toxicity risk is higher in the ROC than in the effluent due to greater contaminant concentrations.

Acute toxicity testing is conducted using a fish species exposed to treated effluent in static or flow-through systems for 24 to 96-hours. Chronic toxicity is a longer term (4 to 7 days), sub-lethal exposure of biological (vertebrate, non-vertebrate and/or plant) species to the discharge. Some chronic toxicity testing includes a measure of lethality, as well. Acute and chronic toxicity testing on approved sensitive species is currently required in the NPDES permits for the discharge locations in each Portfolio. If a fish species is approved for chronic toxicity testing, the results can be used to demonstrate compliance with acute toxicity requirements.

Dilution factors for chronic toxicity are based on actual mixing in the receiving waters and are determined by hydrodynamic modeling. Chronic toxicity testing is performed with samples of total discharge mixed to various dilutions to bracket the authorized dilution factor up to 100% discharge. Under the current San Francisco Bay regulatory approach, South Bay POTW (shallow water outfalls) receive a credit for actual dilution during the reasonable potential analysis (RPA), but accelerated monitoring and investigations are triggered by results without dilution. For POTW that discharge at deep water outfalls, actual dilution is used to determine reasonable potential, but triggers for accelerated monitoring and investigations are based on 10:1 dilution (maximum). Under the proposed Statewide Toxicity Provisions[9], test results at the instream waste concentration, defined as the concentration of effluent in the receiving water after mixing) will be used for the RPA and to determine compliance with water quality-based effluent limitations.

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[8] "First Revised Draft Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California," Division of Water Quality, State Water Resources Control Board, California Environmental Protection Agency, July 25, 2019, Page 1.

[9] Ibid, Page 18

Chronic toxicity testing using Fathead Minnows was performed by Palo Alto in 2018 in anticipation of their planned enhanced non-potable reuse plant. Tests were performed with ROC at 2% and 9% blending with final effluent to represent the different plant capacities that were being considered. No studies were performed at 100% ROC nor at higher than a 9% ROC blend. No dilution credits were assumed. The study report noted “Data from this study suggest that blending RWQCP with ROC from [AWPFs] with permeate production capacities of 3.9 MGD or less pose little additional risk in violating toxicity discharge limits.”… “However, the high variability associated with biological analyses combined with the varying nature of final effluent and ROC makes determination of significant differences impossible within this single chronic toxicity test.”[10]

The permeate production capacity of the AWPFs considered in this study are about six times as high at 24 MGD and the ROC blending ratios are considerably lower, hence the current study scenarios are not covered by the conclusion from Palo Alto. Toxicity testing should be performed at higher percentages to reflect ROC production and final effluent blending from the proposed plant(s). When the Statewide Toxicity Provisions are approved, the Water Board may authorize a dilution credit for chronic toxicity based on cyanide attenuation factors for each of the Lower South San Francisco Bay (LSB) NPDES permits. The 2019 NPDES permit for Palo Alto includes a dilution credit of 3.25:1 for cyanide, while the 2020 NPDES permit for San Jose includes a dilution credit of 3:1 and the 2020 permit for Sunnyvale includes a dilution credit of 4:1.

Chronic toxicity testing was also conducted on the SVAWPC ROC. Samples were taken by an automatic sampler from the combined ROC line from the three RO trains at the SVAWPC. These samples were tested in various concentrations starting at 8% and going up to 100% on Fathead Minnows and Ceriodaphnia Dubia. The results of the Ceriodaphnia studies are complicated by salt impacts. A significant toxicity effect was observed more consistently for reproduction where the NOEC was determined to be close to 18% ROC which would require a dilution of 6:1 to comply with chronic toxicity requirements. Effect on survival and reproduction for the Fathead Minnows was considerably better. Even at 100% ROC, there was no observed effect on survival or growth. Since the evaluation was performed using a fish species, the results also apply to acute toxicity.

4.3 Contaminants of Emerging Concern (CEC)

There are thousands of chemical compounds entering the environment which originate from consumer products, pharmaceuticals, and industrial processes.

> More than 100,000 chemicals have been registered or approved for commercial use in the US. For many of these chemicals, major information gaps limit evaluations of their potential risks, and environmental monitoring of these chemicals has not been required by regulatory agencies. Nevertheless, researchers and government agencies have begun to collect occurrence, fate, and toxicity data for a number of these chemicals.
>
> As a result, a growing number of chemicals have been classified as contaminants of emerging concern (CEC), broadly defined as synthetic or naturally occurring chemicals that are not regulated or commonly monitored in the environment, but have the potential to enter the environment and cause adverse ecological or human health impacts. The primary challenge for

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[10] “Reverse Osmosis Concentrate Toxicity Study *Revised*,” Samantha Engelage, P.E, and Dan Patten, P.E., Palo Alto Regional Water Quality Control Plant, December 12, 2018.

> scientists and regulators is investigating and managing this ever-expanding number of emerging contaminants to ensure that they do not harm human and ecological health.[11]

The RMP has established a priority system for CEC that are known to occur in the Bay. "Criteria used for placement in each tier:

High Concern – Bay occurrence data suggest a high probability of a moderate or high level effect on Bay wildlife (e.g., frequent detection at concentrations greater than the EC10, the effective concentration where 10% of the population exhibit a response, or another effects threshold).

Moderate Concern – Bay occurrence data suggest a high probability of a low level effect on Bay wildlife (e.g., frequent detection at concentrations greater than the predicted no effect concentration (PNEC) or no observed effect concentration (NOEC) but less than EC10, or another low level effects threshold).

Low Concern – Bay occurrence data suggest a high probability of no effect on Bay wildlife (i.e., Bay concentrations are well below toxicity thresholds and potential toxicity to wildlife is sufficiently characterized).

Possible Concern – Uncertainty in measured Bay concentrations or toxicity thresholds suggest uncertainty in the level of effect on Bay wildlife."[12]

The implications of the priority list are below:

High Concern listing will result in implementation of:

- 303d listing,
- TMDL or alternative management plan, and
- Aggressive control/treatment actions for all controllable sources.

Moderate Concern will result in implementation of:

- Action plan/strategy,
- Aggressive pollution prevention, and
- Low-cost control/treatment actions.

Low Concern will result in implementation of:

- Low-cost source identification and control,
- Low-level pollution prevention, and
- Track product use and market trends.

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[11] Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations, Sutton, R., et al., San Francisco Estuary Institute, Regional Monitoring Program for Water Quality in San Francisco Bay (2017 Revision).

[12] Ibid.

Possible Concern will result in implementation of:

- Maintaining an ongoing/periodic effort to identify and prioritize emerging contaminants of potential concern,
- Track international and national efforts to identify high priority CEC, and
- Develop biological screening methods and identify available analytical methods.[13]

At this time no CEC have been listed as High Concern.

Moderate Concern contaminants include:

- Perfluorooctane Sulfonate (PFOS)
- Fipronil
- Nonylphenols (NP) and Nonylphenol Ethoxylates (NPE)

There are quite a few contaminants of Low Concern and Possible concern, including:

- Flame Retardants
- Pharmaceuticals and Personal Care Products
- Microplastic
- Pesticides
- Other PFAS

These contaminants will continue to be monitored, tracked, and trended.

4.4 Metals

Metals are contaminants of concern since they can have adverse effects on marine ecosystems in small concentrations. For this project, the metals with compliance concerns are selenium, copper, and nickel.

Chelated Metals

A significant proportion of the copper and nickel in final effluent discharged to the San Francisco Bay is chelated with an EDTA-like substance.[14] The presence of synthetic chelating agents in municipal wastewater poses a challenge for ROC management since the pollutant metal-EDTA complexes are difficult to remove in standard wastewater treatment processes and consequently end up in high concentrations in the final effluent supplied to the proposed AWPF.[15]

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[13] Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations, Sutton, R., et al., San Francisco Estuary Institute, Regional Monitoring Program for Water Quality in San Francisco Bay (2017 Revision).

[14] Sedlak, David, Personal Communication, June 16, 2020.

[15] Ku, Young and Chen, Chi-Hwa, Removal of Chelated Copper from Wastewaters using Iron Cementation, *Industrial and Engineering Chemical Research, 1992.*

Selenium

Selenium is considered a bio-accumulator and therefore concentration-based regulation is not considered protective. Fish tissue and bird egg studies and criteria are considered the “gold standard’ for bio-accumulators. In the North San Francisco Bay, a TMDL was promulgated in 2015 based on fish tissue studies and wasteload allocations issued for each of the North Bay POTW. A similar approach is anticipated for the South San Francisco Bay. The EPA proposed “Aquatic Life and Aquatic-Dependent Wildlife Criteria for Selenium in California’s San Francisco Bay and Delta[16]” in 2016. When the EPA issued the proposed SF Bay-Delta Criteria, they received comments from South SF Bay POTW. As described on the EPA website, “Some commenters expressed concern over whether the proposed criteria were appropriate for the South Bay, because data specific to the North Bay and Delta had been used to develop the water column criteria using the U.S. Geological Survey (USGS) Ecosystem-Scale Selenium Model.” In response, the EPA asked the USGS to investigate whether sufficient site-specific data existed for the South Bay to reliably run the model for the South Bay area.” The USGS issued a report in July 2018 entitled “Status of Selenium in South San Francisco Bay – A Basis for Modeling Potential Guidelines to Meet National Tissue Criteria for Fish and a Proposed Wildlife Criterion for Birds.[17]” The report details the modeling that was conducted and a range of recommended, protective water column concentrations for the South Bay. There has been no activity by the EPA or the Regional Water Board on South Bay selenium since the USGS report was released. However, future action by the regulators is anticipated.

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[16] US EPA Office of Water, EPA 820-F-16-006, June 2016.

[17] US Department of Interior, US Geological Survey, Open-File Report 2018-1105.

5. Methodology for Development of ROC Management Solutions

The contaminants that each management option must address as well as the methodology used to evaluate the compliance of each management option are outlined in this section.

5.1 General List of Contaminants and Initial Screening

The United States Environmental Protection Agency Priority Pollutants List (PPL) includes 126 contaminants. The contaminant list is included in each NPDES permit along with the water quality criterion or objective for each pollutant, the maximum effluent concentration (MEC) measured during the previous permit period, the background concentration, and the Reasonable Potential Analysis (RPA) results for each contaminant. Initial screening was accomplished by taking the MEC for each contaminant, multiplying it by 6.7 (assuming 85% RO recovery and 100% rejection of each contaminant), and comparing it to the applicable water quality criterion or objective. Table 6.1 shows the contaminants that were determined to be greater than the applicable criterion for each facility. Results marked with “+” indicate the concentration was greater and results marked with a “-“ indicate the concentration was less than the applicable criterion.

Table 5.1 Initial Screening, Contaminants that Exceed the Water Quality Criterion without Blending (Using MECs reported in POTW NPDES Permits)

Contaminants	SJ-SC RWF*	PA RWQCP**	SV WPCP***
Copper	+	+	+
Cyanide	+	+	+
Nickel	+	+	+
Zinc	+	+	+
Cadmium	-	+	-
Mercury	+	+	+
Selenium	-	+	+
*Carbon Tetrachloride	-	-	+
*Chlorodibromomethane	+	+	+
*Dichlorobromomethane	+	+	+
*Bis-2-(ethylhexyl) Phthalate	+	+	+
*Indeno(1,2,3-cd) Pyrene	+	-	-
Ammonia	+	+	+
PCB's	+	+	+

* ORDER No. R2-2014-0034; NPDES No. CA0037842; 2014.
** ORDER No. R2-2019-0015; NPDES No. CA0037834; 2019.
*** ORDER No. R2-2014-0035; NPDES No. CA0037621; 2014.

5.2 Further Screening

To further develop the list of contaminants of concern, more recent concentration data provided by Valley Water and downloaded from the California Integrated Water Quality System Project (CIWQS) database for each of the POTW were compiled from January 2015 through September 2019. For this evaluation, analyses that resulted in non-detect or detected but not quantified values were not included. To estimate the concentrations of these contaminants in the ROC, the 95th percentile values were multiplied based on estimated RO rejection efficiency and the assumed 85% recovery. The rejection efficiencies were estimated from AqMB® modeling where available, or through research of compound specific RO rejection efficiency. The rejection efficiencies used are as follows:

Copper – 99.8%
Cyanide – 98.0%
Nickel – 99.8%
Selenium – 99.8%
Bis (2-Ethyhexyl) Phthalate – 99.8%
Cadmium – 99.9%
Carbon Tetrachloride - 90%
Dibromochloromethane – 75%
Dichlorobromomethane – 78%
Indeno (1,2,3-cd) Pyrene - 99.8%
Mercury - 99.8%
Zinc - 99.8%

The derived values represent an estimate of the concentrations that could be expected in the ROC based on reported effluent discharge values for the time period. These ROC concentrations were compared to the Water Quality Criterion (WQC) listed in the RPA table of the POTW NPDES permits. A preliminary comparison of the 95th percentile projected ROC concentrations to the WQC flags the following constituents:

San Jose

- Copper is ~2.2 times the WQC
- Cyanide is ~5.9 times the WQC
- Nickel is ~1.9 times the WQC
- Selenium is ~1.2 times the WQC
- Zinc is ~1.2 times the WQC
- Dibromochloromethane is ~2.0 times the WQC
- Dichlorobromomethane is ~2.1 times the WQC

Palo Alto

- Copper is ~8.8 times the WQC
- Cyanide is ~6.7 times the WQC
- Nickel is ~1.3 times the WQC
- Selenium is ~2.5 times the WQC
- Zinc is ~2.9 times the WQC

Sunnyvale

- Copper is ~2.1 times the WQC
- Cyanide is ~10.7 times the WQC
- Nickel is ~1.3 times the WQC
- Selenium is ~2.6 times the WQC
- Dibromochloromethane is ~4.4 times the WQC
- Dichlorobromomethane is ~3.0 times the WQC
- Zinc is ~1.0 times the WQC

5.3 Establishing List of Contaminants to be Evaluated in this Study

Based on a further evaluation that included non-detect and detected but not quantified values in recent historical water quality data dibromochloromethane and dichlorobromomethane were eliminated from the list of contaminants. Zinc was eliminated due to its low attenuation factor, however after further review, we recommend zinc to be further evaluated. The final list of contaminants that were evaluated is shown below:

- Copper,
- Cyanide,
- Nickel, and
- Selenium.

Historical water quality data for these contaminants were used to evaluate AWPF ROC management options using the strategies presented in this study.

5.4 Mass Balance Modeling

The mass balance model used the historical water quality data for each POTW and the estimated flow balance developed for the CWRMP draft D7 document dated 10/24/2019. Output concentrations for each of the contaminants were determined for the blended wastewater effluent/ROC discharge streams for each Portfolio.

An analysis was conducted on the historical water quality data to determine if there was a correlation between month and concentration of contaminants. No correlation between month and concentration was observed for any of the contaminants. Therefore, the same contaminant concentrations (95%-ile to represent maximum daily concentration and average concentration to represent average monthly concentrations) were used for all months throughout the mass balance modeling effort.

The CWRMP flow balance provides monthly flows for projected future 2025 and 2035 scenarios for each Portfolio. The mass balance model used the historical water quality data and the CWRMP monthly flows to determine the blended ROC concentrations for each month. The results for each month were then summated over each month to calculate, for example, how much purified water can be produced annually (and corresponding ROC discharged) without exceeding NPDES permit limits for the blended discharge.

The general equation for the mass balance is as follows:

$$\frac{(Q_{EFF}*C_{EFF})+(Q_{ROC}*C_{ROC})}{Q_{EFF}+Q_{ROC}} = C_{BD}$$

$Q_{EFF} = Final\ effluent\ to\ outfall$

$C_{EFF} = Concentration\ in\ raw\ effluent$

$Q_{ROC} = ROC\ flow$

$C_{ROC} = Concentration\ in\ ROC$

$C_{BD} = Concentration\ in\ blended\ discharge$

5.5 Development of Approach (Workshop 1: May 2017)

An initial workshop was held in May of 2017 to identify potential ROC Management options. The long list that was developed was evaluated for potential fatal flaws.

5.6 Refinement of ROC Management Strategies (Workshop 2: October, 2017)

Following Workshop 1 held in May 2017 and after receiving input from stakeholders including the four local POTW and regulators from the RWQCB and EPA, a vigorous MCA approach was developed to evaluate each ROC management option. The MCA approach ranked each option according to various weighted evaluation criteria. Originally, 20 management options were evaluated for each location, resulting in a large number of possible ROC management strategies. An initial screening of the options resulted in reducing the number of feasible ROC management options by more than half and the outcome of Workshop 2 culminated in 3 recommended options for each location.

As the portfolios were further defined in the CWRMP, it became apparent that feasible management strategies were reduced to the 7 options presented in Table 5.2.

Table 5.2: ROC Management Alternatives

1	ROC Treatment
2	Blending of ROC with POTW Effluent and Discharge to Existing Outfall under the Existing NPDES Permit
3	Blending of ROC with POTW Effluent and Discharge to Existing Outfall under a separate NPDES permit and/or an Innovative Permitting Strategy
4	Discharge to New Enhanced Mixing Outfall
5	Discharge to a Deep Water Outfall
6	Deep Well Injection
7	Evaporation Ponds

From this list, ROC treatment for the contaminants evaluated and deep well injection were later eliminated. Treatment was eliminated from consideration because pilot studies demonstrated challenges with removing chelated metals and selenium. Deep well injection was removed due to Valley Water's longstanding policy goal of aggressive protection of the potable water aquifer. Additionally, disposal through evaporation ponds was deemed feasible for the Morgan Hill AWPF due to its inland location and relatively small volume of ROC.

5.7 Evaluation of ROC Management Options (Workshop 3: November, 2019)

A list of potential ROC management strategies for each portfolio was presented at Workshop 3. For all ROC management strategies, an Association for the Advancement of Cost Engineering (AACE) Class 5 CAPEX estimate was presented. These parametric estimates included optional treatment costs for nutrients, chronic toxicity, and CEC. Treatment technology envisioned for the removal of these contaminants consisted of a denitrifying filter and a granular activated carbon (GAC) system. Treatment for chelated metals was not considered for CAPEX and OPEX costs. These will be addressed through a combination of blending, mixing, and innovative permitting strategies discussed further in Section 5.10.

A summary of feedback from the stakeholders and regulators identified the major compliance challenges for ROC discharge will be related to CEC and chronic toxicity. The regulators expressed confidence that the Basin Plan could be modified to address compliance strategies for the remaining contaminants such as chelated metals and selenium. However, they emphasized that results of treatment studies must be considered before eliminating treatment as an ROC management option for any Portfolio. A relevant point made at Workshop 3 was that it is not known what proportion of metals in the final effluent is chelated. If a significant percentage of metals is not chelated, traditional treatment methods could be effective at reducing metals concentrations in the ROC to comply with permit limits. This point poses an opportunity for additional investigation to determine the proportion of chelated metals in the final blended effluent.

5.8 Treatment Technologies/Technology Assessments (Workshop 4: March, 2020)

As part of the ROC management evaluations, Valley Water collaborated with University of California, Berkeley and Stanford University to evaluate ozone and open water engineered treatment cells on a suite of contaminants in a pilot system. Ozone and open water treatment cells were evaluated both separately and in conjunction with one another based on general water quality parameters as well as their ability to remove nutrients, metals, and trace organics.

The main objective of Workshop 4 was to present the results of the treatment studies and to evaluate the applicability of treatment as an ROC management option. Although results of the pilot studies demonstrated that the hybrid ozone/open-water wetland system was effective at removing pesticides, nitrogen, and CEC from ROC, they did not show effectiveness at removing chelated metals and PFAS. Therefore, alternate strategies, including further treatment studies, will be required to address these contaminants.

Since the limiting contaminants for NPDES permit compliance for all portfolios were chelated metals, treatment cells were eliminated from consideration as a standalone treatment strategy.

The remaining ROC management options after Workshop 4 included:

- Blending of ROC with POTW effluent and discharging to an existing outfall under the existing NPDES permit

- Blending of ROC with POTW effluent and discharging to the existing outfall under a separate permit and/ or an innovative permitting strategy
- Enhanced mixing outfall
- Discharge to a deep water outfall
- Evaporation ponds (Morgan Hill location only)

The following sections outline in greater detail what each management option entails. The target production was outlined in the CWRMP.

5.9 Blending and Discharge Using an Existing Outfall

This is straightforward in situations where there is sufficient residual effluent to blend the ROC to satisfy NPDES permit limits. Mass balance modeling indicates this management strategy will work for Portfolio 1 but there are dry months where this alternative will not work for the other portfolios without reduction of AWPF permeate capacity (and corresponding ROC discharge) below the target production.

5.9.1 Mass Balance Modeling

According to this evaluation, some of the portfolios will not have sufficient residual effluent to blend ROC for disposal at an existing outfall during portions of the year. A summary of the main findings of this modeling are shown below in Table 5.3. Here, the target annual permeate production in AFY was calculated based on the monthly permeate production using projected 2025 flows and 2035 upper and lower bound flows from the CWRMP. The maximum permeate production achievable while staying within 95% of the current NPDES permit limits was then modeled, assuming blending with residual effluent at the existing discharge was adopted as the ROC management strategy. Operational flexibility will be required to adjust permeate production significantly throughout the year to account for lower influent flows and ensure adequate blending. For the chosen portfolio, additional evaluation of MDEL compliance will need to be included in subsequent design phases as this may impact needed dilution credits.

5.9.1.1 Annual Permeate Production Meeting NPDES Limits when Blending and Discharging at the Current Outfall

Table 5.3 summarizes the results of the modeling using average concentrations to evaluate for the Average Monthly Effluent Limit (AMEL) and 95th percentile concentrations to evaluate for the Maximum Daily Effluent Limit (MDEL) coupled with the flows provided by CWRMP. For every month for each Portfolio, the controlling limit as determined by the AMEL or MDEL was used to estimate the annual permeate production. The controlling contaminant and NPDES permit limit for each portfolio are also shown in the table.

Table 5.3: Permeate Production vs Target Permeate Production

Portfolio	Controlling NPDES Permit Contaminant and Limit	Target Annual Permeate Production (AFY)*			Annual Permeate Production Meeting NPDES Permit Limits for Regulated Contaminants** (AFY)		
		2025	**2035 Lower Bound**	**2035 Upper Bound**	**2025**	**2035 Lower Bound**	**2035 Upper Bound**
Portfolio 1 San Jose	None	24,200	24,200	24,200	24,200	24,200	24,200
Portfolio 2A Palo Alto	Copper (MDEL)	19,700	17,300	23,000	16,100	12,700	18,600
Portfolio 2B Sunnyvale	Copper (AMEL)	19,700	17,300	23,000	10,000	7,800	11,800
Portfolio 4 Sunnyvale	Copper (AMEL)	8,400	6,400	10,600	7,700	5,600	9,700
Portfolio 4 Palo Alto	Copper (MDEL)	12,000	11,700	13,200	8,100	7,200	8,400

*Annual permeate production expressed in AFY to be consistent with the CWRMP.

**For example, for Portfolio 2A in 2035 using lower bound flows, the total annual permeate production would be approximately 12,700 AF.

5.9.1.2 95th Percentile concentrations for AMEL

At the request of stakeholders, a more conservative analysis was conducted using 95th percentile concentrations to compare against the AMEL coupled with lower bound average monthly flows provided by CWRMP in D7 for 2035. This is a conservative assumption since it is unlikely that the average concentration in the effluent will be continuously at the 95th percentile historical concentration. In all cases for this analysis, the AMEL was the limiting constraint. The annual permeate production estimates for each portfolio adhering to these criteria are shown below in Table 5.4.

Table 5.4: Permeate Production vs Target Permeate Production (95%-ile Concentration for AMEL and Lower Bound Flows)

Portfolio	Controlling NPDES Permit Contaminant	Target Annual Permeate Production (AFY)	Annual Permeate Production Meeting NPDES Permit Limits for Regulated Contaminants (using AMEL) (AFY)
		2035	**2035**
Portfolio 1 San Jose	None	24,200	24,200
Portfolio 2A Palo Alto	Copper	17,300	7,900
Portfolio 2B Sunnyvale	Copper	17,300	500
Portfolio 4 Sunnyvale	Cyanide	6,400	3,300
Portfolio 4 Palo Alto	Copper	11,700	3,200

5.9.1.3 Monthly Production based on Lowest Daily Historical Flows

An additional conservative modeling effort was proposed by Palo Alto to ensure that compliance with MDEL could be maintained.

This effort was conducted using the lowest observed daily flows for each month and the 95th percentile concentrations from the years 2015 to 2020. The analysis assumes that the daily flow from Palo Alto is always the lowest flow observed in a given month within the five-year monitoring window. The table below summarizes the minimum daily permeate production in MGD and acre-feet-per-day (AFD) assuming these criteria and adherence to within 95% of the MDEL.

Table 5.5: Minimum Daily Permeate Production (Lowest Observed Daily Flows and 95%-ile Concentrations)

Month	Minimum Daily Permeate Production (MGD and AFD)			
	Portfolio 2A Palo Alto Limiting Constituent: Copper		**Portfolio 4 Palo Alto** Limiting Constituent: Copper	
	MGD	**AFD**	**MGD**	**AFD**
January	12.9	39.6	6.2	19.0
February	13.1	40.2	6.5	19.9
March	11.3	34.7	5.1	15.7
April	8.6	26.4	3.5	10.7
May	8.2	25.2	3.9	12.0
June	4.4	13.5	0.9	2.8
July	3.3	10.1	0.1	0.3
August	2.6	8.0	0	0.0
September	5.4	16.6	2	6.1
October	5.4	16.6	1.4	4.3
November	8.6	26.4	3.3	10.1
December	11.3	34.7	5.2	16.0
Total (AFY)	8,800		3,500	

5.10 Blending and Discharge under a Joint, Modified, or Separate Permit and/or an Innovative Permitting Strategy

Communication with the Water Board will be ongoing as this project is developed. New effluent limits and discharge prohibitions will be developed through discussions between the Water Board, Valley Water, and the POTW that contribute effluent or share access to their outfalls. The agreed-upon compliance strategy and permit structure will be incorporated into a final permit for adoption by the Water Board and subsequent approval by the EPA.

5.10.1 Anti-Backsliding

Federal anti-backsliding requirements prohibit the issuance of a renewed or modified NPDES permit that contains less stringent effluent limitations than provided in a previous permit for the same facility.

However, exceptions to this rule can be justified in certain cases. One of these exceptions (Clean Water Act (CWA)), Section 402 (o) (2)) is “if material and substantial alterations to the permitted facility occurred after permit issuance which justify the application of a less stringent effluent limitation”. This exception may be applicable for a reissued NPDES permit since addition of an AWPF facility and its waste stream constitute a substantial alteration to the existing facility.

5.10.2 Dilution Credit

The existing outfalls for the three POTW locations (Palo Alto, Sunnyvale, and San José) have different hydraulic characteristics. Palo Alto has the outfall with the best mixing and Sunnyvale has the outfall that is most limiting in terms of dilution. Palo Alto has been granted dilution credits for copper and cyanide, while Sunnyvale has a dilution credit for cyanide only. Therefore, it is likely dilution credit(s) for additional contaminant(s) may be possible for Palo Alto, but less likely for Sunnyvale.

Table 5.6 shows the estimated minimum dilution credits (calculated from the model run using the Lower Bound flows from Table 5.3) that would be required for the ROC to achieve NPDES permit compliance (within 95% of permit limit for each evaluated constituent) when discharging to the existing outfall under Portfolios 2A, 2B and 4.

Table 5.6: Estimated Minimum Dilution Credits Needed for Portfolios to Meet NPDES Permits (Lower Bound Flows)

Portfolio	Location	Contaminant	Additional Dilution Credit 2035 (S*)
Portfolio 2A	Palo Alto	Copper	2.00
		Cyanide	2.25
Portfolio 2B	Sunnyvale	Copper	4.75
Portfolio 4	Palo Alto	Copper	2.50
		Cyanide	2.25
		Nickel	2.50
	Sunnyvale	Copper	3.25
		Cyanide	2.75

*Dilution is expressed two different ways in NPDES permits. To describe dilution in the receiving water, values are shown as dilution credits (“S,” defined as parts effluent + parts receiving water to parts effluent). To calculate effluent limits, values are shown as dilution factors (“D,” defined as parts receiving water to parts effluent). The values are translated as D = S-1.

5.11 Enhanced Mixing Outfall

Hydrodynamic modeling was performed to evaluate instream waste characteristics at the Palo Alto, San Jose and Sunnyvale outfalls. Effluent from the Palo Alto location discharged most directly to the open waters of the Lower South Bay and showed the best dilution characteristics and smallest mixing zone.[18] Even though the hydrodynamic modeling did not evaluate an enhanced mixing outfall location for Palo Alto, a well-mixed location was shown about 1,000 feet from the shoreline. For San Jose, the model looked at extending the outfall approximately 5,000 feet to Coyote Creek. For Sunnyvale, the most limited in dilution, the model looked at extending the outfall approximately 33,000 feet to Guadalupe Slough. It was assumed that both of the enhanced mixing outfalls would include diffusers for increased dilution. These enhancements would greatly improve dilution/mixing of the effluent discharge. Improved mixing of these discharges would increase the ability to meet NPDES permit requirements, especially in the case of Sunnyvale. For Palo Alto, an outfall extension was proposed in the late 1980's but wasn't permitted by regulatory agencies.[19] However, reconsideration may be warranted based on a different pipeline alignment, less invasive construction techniques, and the benefits of operating a new AWPF to increase local water supply reliability. Working with the Water Board to realize the net environmental benefit of a new AWPF for potable reuse may result in approval of this outfall.

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[18] “Hydrodynamic Modelling and Analysis of ROC Discharge Options: Outfall Location and Dilution Modelling Analysis,” Technical Memorandum Prepared by Resource Management Associates, Walnut Creek, CA. June 2019

5.12 Discharging to a Deep Water Outfall

For some contaminants of concern (i.e., chelated metals and chronic toxicity) the dilution achieved by discharging to a deep water outfall would reduce the risk of NPDES permit noncompliance. This solution proposes to convey ROC by pipeline to an outfall in the deep portion of San Francisco Bay and discharge through a diffuser. This alternative manages the discharge non-compliance risks for all of the contaminants, except contaminants regulated on a mass-loading basis to the SF Bay.

Existing deep water outfalls with available capacity such as those operated by East Bay Dischargers Authority (EBDA) or Silicon Valley Clean Water (SVCW) might be considered. This work will be addressed in Phase 2 of the ROCM to be completed at a later date after Valley Water has had the opportunity to meet with either EBDA or SVCW to discuss further and determine feasibility.

5.13 Evaporation Ponds

Disposal by evaporation ponds is under consideration for the local AWPF at Morgan Hill due to its inland location and low ROC flowrates. These ponds would be cleaned annually. This option was not considered for the other locations due to land availability and population density. More investigation would be needed to evaluate the impact of odor issues on the surrounding population. For this option, the major challenge includes the cost of land necessary to accommodate disposal of the ROC.

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[19] Meeting with Palo Alto RWQCP Staff in May 2020

6. ROC Management Options

In this section ROC management options are evaluated for each of the portfolios to a 10% design level. This includes CAPEX and life-cycle costs (LCC) evaluated to the AACE Class 4 Standards, meaning they have an expected accuracy range of between -15% to -30% and +20% to +50%. For these estimates, we considered conceptual pipe diameter and routings, tank and pump sizing, treatment process footprints and operating costs, excavation and off-hauling costs. For the Morgan Hill AWPF, a cost estimate for the evaporation pond liner was also included.

Class 4 AACE CAPEX estimates are defined as being based on “equipment factored or parametric models”. In this project, we obtained quotes for the following components:

- Butterfly valves,
- Concrete ROC holding tanks,
- Duplex steel grade pumps,
- Evaporation pond geo-synthetic liner.

Pipe was assumed to be high density polyethylene (HDPE), which is a commodity and sold by the pipe mass ($0.70/lb). The mass of the pipe was dependent on pressure class and diameter and was obtained from standard literature. The CAPEX estimates were developed using this information. Land acquisition costs were not included as the land would likely be leased and the footprint of the additional treatment works would add slightly to the footprint of the AWPF.

For treatment of nutrients, to be cautious, nitrogen and phosphorus were included. A denitrifying filter was conceptually designed which also could be used for phosphorus removal. The design assumed that all ammonia was nitrified at the wastewater treatment plant. A conservative 50% removal of each nutrient was targeted for purposes of design and operating costs. This design may be revisited in the future. CAPEX was parametrically estimated at $0.60 per gallon per day. Operation costs were developed for additional pumping and chemical costs for methanol feed for denitrification and ferric chloride feed for phosphorus removal. The operating costs were estimated to be $1,058 per million gallons of ROC treated.

For treatment of CEC, a GAC system was conceptually designed. The design used three reactors with two operating in series at any time. Monitoring for breakthrough of target compounds would be performed after the first reactor. When a breakthrough is detected, the first contactor is taken offline and GAC replaced; the second reactor moves into the first position; and the third reactor moves into the second position. Sizing was based on empty bed contact time (EBCT) of 10 minutes for each reactor with 20 minutes EBCT online at any time. CAPEX was parametrically estimated at $0.50 per gallon per day. Operation costs were developed assuming 1 year replacement interval for each reactor. These costs were estimated to be $95 per million gallons ROC treated.

As discussed in Workshop 4, treatment for removal of chelated metals and selenium was not considered for CAPEX and OPEX costs and these will be addressed through a combination of blending, mixing, and innovative permitting strategies.

Life-cycle costs were developed using the guidelines given by Valley Water to remain consistent with the CWRMP including the real discount rate, electricity costs, and construction period. These costs will be added to the life-cycle unit costs developed in the CWRMP. As shown in Tables 4.3 and 4.4 in D7, 30-year life-cycle unit costs for the Portfolios range from $3,000/AF for Portfolio 1A to $3,700/AF for Portfolio

4 while 100-year life-cycle unit costs for the Portfolios range from $2,300/AF for Portfolio 1A to $2,800/AF for Portfolio 4. All proposed ROC Management Strategies comprise less than 10% of the total unit cost of potable reuse water.[20]

6.1 Portfolio 1

This portfolio includes an expanded SVAWPC at San Jose, which will consist of a new AWPF with a production capacity of 24 MGD in addition to the existing 8 MGD SVAWPC.

The ROC management options for this portfolio are:

- Blending at a new outfall past the compliance location of the SJ-SC WRF
- Discharge at a new enhanced mixing outfall in Coyote Creek

Although the mass balance modeling showed that because of the large amount of final effluent available, this portfolio meets the discharge requirements of the current NPDES permit, blending and discharging at the existing outfall was not considered due to potential permitting and compliance issues.

6.1.1 Portfolio 1: Blending and Discharging "Outside the Fence Line"

Description

One ROC management option for Portfolio 1 is blending of ROC at a new outfall "outside the fence line" of the SJ-SC WRF. This would entail installing a pumping station and pipeline that extends beyond the current outfall weir for the plant (or compliance location). A new permit would be necessary that would coordinate between Valley Water and the City of San Jose. The preliminary design for this option is shown below in Table 6.1.

Table 6.1 Preliminary Design for Portfolio 1: Blending after the Effluent Weir

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter	18	inches
Pipeline Length	9,536	feet
Pipeline Length	1.8	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,600	sq.ft.

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[20] This does not account for treatment for metals. If this is later discovered to be feasible, it could add considerable costs. However, these are not quantified since no feasible treatment technology currently exists.

6.1.1.1 CAPEX and LCC

Table 6.2 shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III.

Table 6.2 CAPEX and Life-Cycle Costs for Portfolio 1: Blending after the Effluent Weir

CAPEX		
Blending After the Effluent Weir	$19.3M	
Life Cycle Costs	30 year	100 year
Blending after the Effluent Weir	$151/AF	$128/AF

6.1.2 Portfolio 1: Enhanced Mixing Outfall

Description

Discharging to a new enhanced mixing outfall in Coyote Creek would be a way to increase dilution and improve water quality in the Lower South Bay. The preliminary design for this option is shown below in Table 6.3.

Table 6.3 Preliminary Design for Portfolio 1: Extension to Coyote Creek

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	100	HP
Pipeline Diameter	18	inches
Pipeline Length	19,986	feet
Pipeline Length	3.8	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,600	sq.ft.

6.1.2.1 Hydrodynamic Modeling

Early in this study, a numerical model was developed by Resource Management Associates (RMA) under the guidance of SFEI to evaluate the hydrodynamics and dilution characteristics of the LSB to support the evaluation of ROC management options. Hydrodynamic modeling was performed by RMA to evaluate instream waste characteristics at the Palo Alto, San Jose, and Sunnyvale outfalls and two alternate discharge locations.[21] The dilution results from this study were intended to help compare the mixing characteristics of these discharge locations and to be used in support of the incorporation of a dilution credit during NPDES permit negotiations. The results of the hydrodynamic model showed a location of enhanced mixing for San Jose approximately 5,000 ft. into Coyote Creek. Using an enhanced mixing outfall, better compliance with chronic toxicity would be assured. Figure 6.1 shows an example of the dilution factors available in the area of the existing SJ-SC RWF.

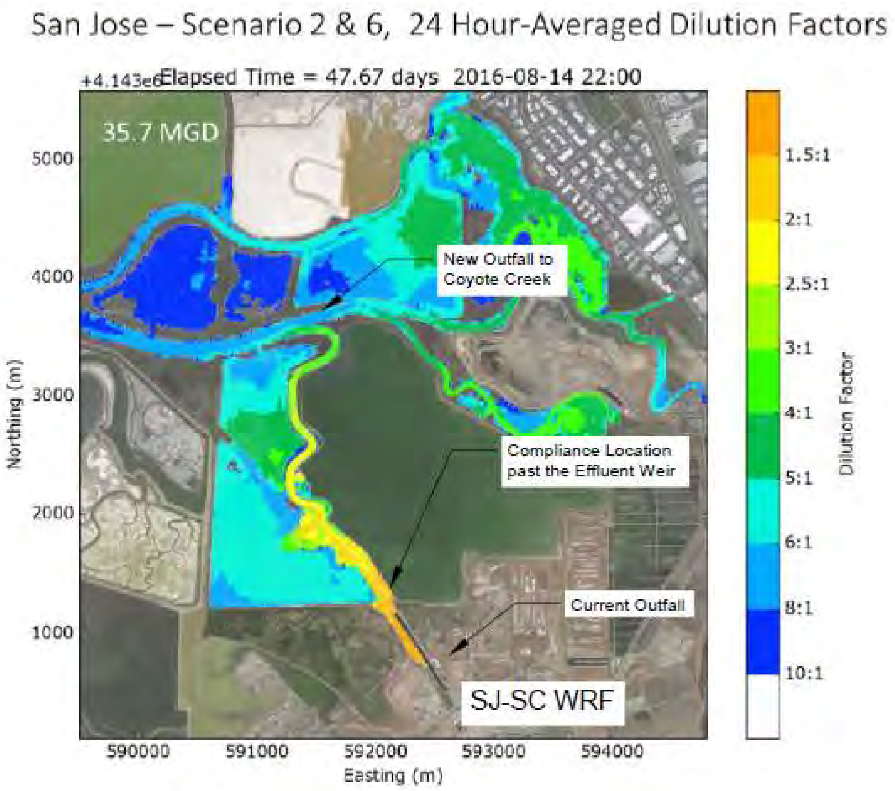
San Jose – Scenario 2 & 6, 24 Hour-Averaged Dilution Factors
+4.143e6
Elapsed Time = 47.67 days 2016-08-14 22:00
35.7 MGD
5000
4000
3000
2000
1000
Northing (m)
590000
591000
592000
593000
594000
Easting (m)
New Outfall to Coyote Creek
Compliance Location past the Effluent Weir
Current Outfall
SJ-SC WRF
1.5:1
2:1
2.5:1
3:1
4:1
5:1
6:1
8:1
10:1
Dilution Factor

Figure 6.1: Example of Hydrodynamic Results for Dilution Factors near SJ-SC RWF[22]

6.1.2.2 CAPEX and LLC

Table 6.4 shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

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[21] “Hydrodynamic Modelling and Analysis of ROC Discharge Options: Outfall Location and Dilution Modelling Analysis,” Technical Memorandum Prepared by Resource Management Associates, Walnut Creek, CA. June 2019

[22] Adapted From “Hydrodynamic Modelling and Analysis of ROC Discharge Options: Outfall Location and Dilution Modelling Analysis”.

Table 6.4 CAPEX and Life-Cycle Costs for Portfolio 1: Extension to Coyote Creek

CAPEX		
Extension to Coyote Creek	$29.0M	
Life Cycle Costs	30 year	100 year
Extension to Coyote Creek	$178/AF	$145/AF

6.2 Portfolio 2A

This portfolio includes a Regional AWPF at Palo Alto, which will consist of a new AWPF with a production capacity of 24 MGD. The ROC management options for this portfolio are:

- Blending and discharging at the existing outfall
- Discharge at a new enhanced mixing outfall
- Discharging at an existing deep water outfall at SVCW

Because the costs of these discharge locations varies widely, negotiations with the Water Board will guide selection of the ROC management option.

6.2.1 Portfolio 2A: Blending and Discharging

Description

Blending and discharging at the existing outfall under the existing NPDES permit is the simplest ROC management solution. The mass balance modeling showed this option does not meet the discharge requirements of the current NPDES permit 100% of the time. Therefore, during periods when there is insufficient final effluent to blend with ROC and ensure NPDES permit compliance, permeate production would need to be reduced. The preliminary design for this option is shown below in Table 6.5.

Table 6.5 Preliminary Design for Portfolio 2A: Blending with Palo Alto Effluent

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank at AWPF site	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter	18	inches
Pipeline Length	10,849	feet
Pipeline Length	2.1	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,600	sq.ft.

6.2.1.1 CAPEX and LCC

Table 6.6 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.6 CAPEX and Life-Cycle Costs for Portfolio 2A: Blending with Palo Alto Effluent

CAPEX		
Blending with Palo Alto Effluent	$18.2M	
Life Cycle Costs	30 year	100 year
Blending with Palo Alto Effluent	$131/AF	$112/AF

6.2.2 Portfolio 2A: Enhanced Mixing Outfall

Description

An alternate ROC management option for Portfolio 2A is to discharge at a location approximately 1,000 feet into the San Francisco Bay. Discharging to this new enhanced mixing location could be used to achieve higher dilution. An outfall extension was proposed in the late 1980’s but wasn’t permitted by regulatory agencies. (See reference in Section 5.11) However, reconsideration may be warranted based on a different pipeline alignment, less invasive construction techniques, and the benefits of operating a new AWPF to increase local water supply reliability. The preliminary design for this option is shown below in Table 6.7.

The pipe length from the proposed Regional AWPF location at the former Los Altos treatment plant to the existing outfall was estimated at 11,000 feet. An additional length of about 5,000 feet from the current outfall in an unnamed slough to the shoreline and an additional 1000 feet would be needed to reach the enhanced mixing point in the Bay.

Table 6.7 Preliminary Design for Portfolio 2A: Extension into San Francisco Bay

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter	18	inches
Pipeline Length	14,563	feet
Pipeline Length	2.8	miles
Pipeline Diameter (marine portion)	18	inches
Pipeline Length (marine portion)	1000	feet
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,080	sq.ft.

6.2.2.1 Hydrodynamic Modeling

Although an alternate discharge location for Palo Alto was not identified in the Hydrodynamic modeling done by RMA, the hydrodynamic model indicated an area of excellent mixing close to the outfall of the Palo Alto RWQCP in San Francisco Bay. Figure 6.2 shows an example of the dilution factors available near the Palo Alto RWQCP.

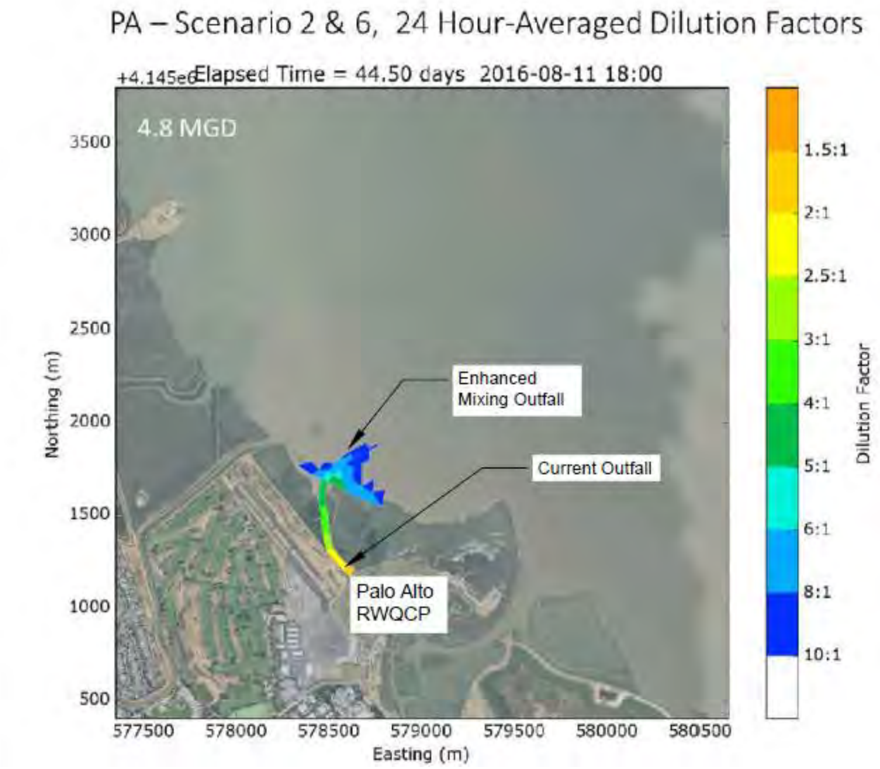

Figure 6.2: Example of Hydrodynamic Results for Dilution Factors near PA RWQCP[23]

6.2.2.2 CAPEX and LCC

Table 6.8 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.8 CAPEX and Life-Cycle Costs for Portfolio 2A: Extension into San Francisco Bay

CAPEX		
Extension into San Francisco Bay	$35.7M	
Life Cycle Costs	30 year	100 year
Extension into San Francisco Bay	$178/AF	$139/AF

6.2.3 Portfolio 2A: Deep Water Discharge

Description

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[23] Adapted From "Hydrodynamic Modelling and Analysis of ROC Discharge Options: Outfall Location and Dilution Modelling Analysis".

Another ROC management option for Portfolio 2A is to connect to an existing deep-water outfall, located in Redwood City. This outfall currently services Silicon Valley Clean Water's wastewater treatment plant. The capacity of this outfall must be verified. Costs to improve this outfall have not been included in this analysis.

The pipe length from the proposed Regional AWPF location at the former Los Altos treatment plant to the existing SVCW outfall was estimated at just over 70,000 feet. The shortest route for this pipeline involves significant construction in the U.S. 101 corridor. It may be possible to use another route. Another possibility is to connect to the existing SVCW collection system, but finding a pipeline that has capacity for approximately 4.24 MGD additional flow may be difficult. Conservatively, this conceptual design brings the pipeline all the way to the outfall. The preliminary design for this option is shown below in Table 6.9.

Table 6.9 Preliminary Design for Portfolio 2A: Deep Water Discharge

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	300	HP
Pipeline Diameter	20	inches
Pipeline Length	70,257	feet
Pipeline Length	13.3	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,600	sq.ft.

6.2.3.1 CAPEX and LCC

Table 6.10 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.10 CAPEX and Life-Cycle Costs for Portfolio 2A: Deep Water Discharge

<table>
<tr><th colspan="3">CAPEX</th></tr>
<tr><td>Deep Water Discharge</td><td colspan="2">$75.3M</td></tr>
<tr><th>Life Cycle Costs</th><th>30 year</th><th>100 year</th></tr>
<tr><td>Deep Water Discharge</td><td>$294/AF</td><td>$209/AF</td></tr>
</table>

6.3 Portfolio 2B

This portfolio includes a Regional AWPF at Sunnyvale, which will consist of a new AWPF with a production capacity of 24 MGD. The only ROC management option for this portfolio is:

- Discharge at a new enhanced mixing outfall

For this portfolio, blending and discharging at the existing outfall was not considered due to the poor dilution characteristics of the receiving water and limited available effluent for blending.

6.3.1 Portfolio 2B: Enhanced Mixing Outfall

Description

The existing outfall located at Sunnyvale has the poorest dilution of the existing POTW outfalls. All shallow water dischargers have approved site specific “attenuation factors” (i.e., dilution credits) and in the case of Palo Alto and Sunnyvale, they both receive a cyanide dilution credit since it degrades readily in the receiving water. Any request for a dilution credit for metals would require additional scientific support. Therefore, the only ROC management strategy for Sunnyvale is to discharge to a new shallow water outfall at Guadalupe Slough, where enhanced mixing will occur at the discharge point. This approach will also require an innovative permit approach to include dilution credits for metals. The preliminary design for this option is shown below in Table 6.11.

Table 6.11 Preliminary Design for Portfolio 2B: Extension to Guadalupe Slough

Design Item	Value	Units
ROC Flow	4.24	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.75	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	150	HP
Pipeline Diameter	18	inches
Pipeline Length	32,760	feet
Pipeline Length	6.2	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,600	sq.ft.

6.3.1.1 Hydrodynamic Modeling

As indicated in Figure 6.3, the area around the existing outfall at Sunnyvale has very poor dilution. Improved mixing can be seen from the figure near the identified alternative location at the entrance of Guadalupe Slough.

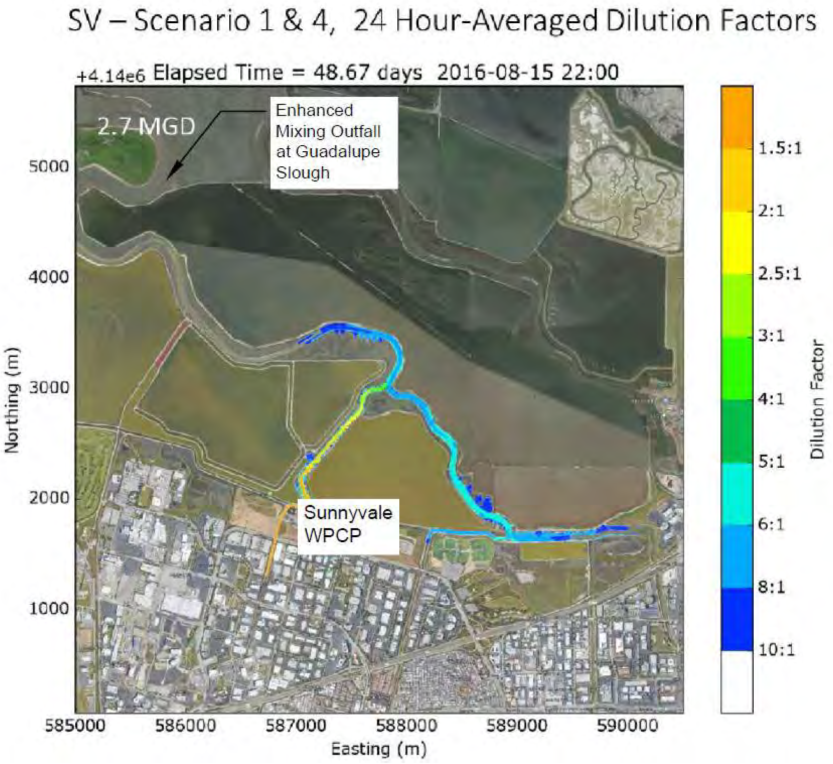
SV – Scenario 1 & 4, 24 Hour-Averaged Dilution Factors
+4.14e6 Elapsed Time = 48.67 days 2016-08-15 22:00
2.7 MGD
Enhanced Mixing Outfall at Guadalupe Slough
Sunnyvale WPCP
5000
4000
3000
2000
1000
Northing (m)
585000
586000
587000
588000
589000
590000
Easting (m)
1.5:1
2:1
2.5:1
3:1
4:1
5:1
6:1
8:1
10:1
Dilution Factor

Figure 6.3: Example of Hydrodynamic Results for Dilution Factors near Sunnyvale WPCP[24]

6.3.1.2 CAPEX and LCC

Table 6.12 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.12 CAPEX and Life-Cycle Costs for Portfolio 2B: Extension to Guadalupe Slough

CAPEX		
Extension to Guadalupe Slough	$38.3M	
Life Cycle Costs	30 year	100 year
Extension to Guadalupe Slough	$189/AF	$146/AF

---

[24] Adapted From “Hydrodynamic Modelling and Analysis of ROC Discharge Options: Outfall Location and Dilution Modelling Analysis”.

6.4 Portfolio 4

This portfolio includes two regional AWPFs, one at Palo Alto and one at Sunnyvale, with a combined production capacity of 24 MGD. The ROC management options for this portfolio are:

- Blending and discharging at the existing outfall in Palo Alto and discharging at an enhanced mixing outfall in Sunnyvale
- Discharge at a new enhanced mixing outfall for Palo Alto and Sunnyvale
- Discharging at an existing deep water outfall at SVCW for Palo Alto and discharging at an enhanced mixing outfall at Sunnyvale

Because the costs of these discharge locations varies widely, negotiations with the Water Board will guide the selection of the ROC management option.

6.4.1 Portfolio 4: Blending and Discharging

Description

One ROC management strategy for Portfolio 4 consists of blending with Palo Alto effluent for the AWPF at Palo Alto and an Extension to Guadalupe Slough for the AWPF at Sunnyvale. These strategies are described in Sections 6.2.1 and 6.3.1, respectively, albeit with lower flows for each AWPF in Portfolio 4. The mass balance modeling showed this option does not meet the discharge requirements of the current NPDES permit 100% of the time. When the discharge does not meet effluent limits in the NPDES permit, permeate production would need to be reduced. The preliminary design for this option is shown below in Table 6.13 and Table 6.14.

Table 6.13 Preliminary Design for Portfolio 4: Blending with Palo Alto Effluent

Design Item	Value	Units
ROC Flow-Palo Alto	2.47	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.42	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter	14	inches
Pipeline Length	10,849	feet
Pipeline Length	2.1	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

Table 6.14 Preliminary Design for Portfolio 4: Extension to Guadalupe Slough at Sunnyvale

Design Item	Value	Units
ROC Flow – Sunnyvale	1.76	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.32	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	100	HP
Pipeline Diameter	12	inches
Pipeline Length	32,760	feet
Pipeline Length	6.2	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

6.4.1.1 CAPEX and LCC

Table 6.15 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively. As was the case in Portfolios 2A and 2B, the blended ROC did not meet current NPDES permit limits at all times. For the purposes of this estimate it was assumed that a new NPDES permit would be negotiated at Palo Alto.

Table 6.15 CAPEX and Life-Cycle Costs for Portfolio 4: Blending with Palo Alto Effluent and Extension to Guadalupe Slough at Sunnyvale

CAPEX		
Blending with Palo Alto Effluent and Extension to Guadalupe Slough	$41.8M	
Life Cycle Costs	**30 year**	**100 year**
Blending with Palo Alto Effluent and Extension to Guadalupe Slough	$199/AF	$152/AF
*These costs assume that a new NPDES permit can be negotiated for the Palo Alto discharge that allows discharge to meet limits at all times.		

6.4.2 Portfolio 4: Enhanced Mixing Outfall

Description

An alternate management strategy for Portfolio 4 consists of extension of the discharge into San Francisco Bay for the AWPF at Palo Alto and extension to Guadalupe Slough for the AWPF at Sunnyvale. The preliminary design for this option is shown below in Table 6.16 and Table 6.17.

Table 6.16 Preliminary Design for Portfolio 4: Extension into San Francisco Bay (Palo Alto)

Design Item	Value	Units
ROC Flow-Palo Alto	2.47	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.43	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter (land portion)	14	inches
Pipeline Length (land portion)	14,563	feet
Pipeline Length (land portion)	2.8	miles
Pipeline Diameter (marine portion)	18	inches
Pipeline Length (marine portion)	1000	Feet
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

Table 6.17 Preliminary Design for Portfolio 4: Extension to Guadalupe Slough (Sunnyvale)

Design Item	Value	Units
Flow – Sunnyvale	1.76	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.32	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	100	HP
Pipeline Diameter	12	inches
Pipeline Length	32,760	feet
Pipeline Length	6.2	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

6.4.2.1 Hydrodynamic Modeling

Hydrodynamic modeling results for the Palo Alto and Sunnyvale locations are described above in Sections 0 and 0, respectively.

6.4.2.2 CAPEX and LCC

Table 6.18 shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.18 CAPEX and Life-Cycle Costs for Portfolio 4: Extension into San Francisco Bay at Palo Alto and Extension to Guadalupe Slough at Sunnyvale

CAPEX		
Extension into San Francisco Bay and Extension to Guadalupe Slough	$58.8M	
Life Cycle Costs	30 year	100 year
Extension into San Francisco Bay and Extension to Guadalupe Slough	$244/AF	$179/AF

6.4.3 Portfolio 4: Deep Water Discharge

Description

An additional ROC management strategy for Portfolio 4 consists of a deep-water outfall for the AWPF at Palo Alto and Extension to Guadalupe Slough for the AWPF at Sunnyvale. These strategies are described in Sections 0 and 6.3.1, respectively, with lower flows for each AWPF in Portfolio 4. The preliminary design for this option is shown below in Table 6.19 and

Table 6.20.

Table 6.19 Preliminary Design for Portfolio 4 Deep Water Discharge (Palo Alto)

Design Item	Value	Units
ROC Flow-Palo Alto	2.47	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.42	MG
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	200	HP
Pipeline Diameter	14	inches
Pipeline Length	70,257	feet
Pipeline Length	13.3	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

Table 6.20 Preliminary Design for Portfolio 4 Extension to Guadalupe Slough (Sunnyvale)

Design Item	Value	Units
ROC Flow – Sunnyvale	1.76	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	0.32	MG
Pumps	3	Number
Pumps	2+1	Service + Standby
Pump Power	100	HP
Pipeline Diameter	12	inches
Pipeline Length	32,760	feet
Pipeline Length	6.2	miles
Denitrifying Filter Footprint	1,200	sq.ft.
GAC Footprint	1,100	sq.ft.

6.4.3.1 Hydrodynamic Modeling

Hydrodynamic modeling results for the Palo Alto and Sunnyvale locations are described above in Sections 0 and 0.

6.4.3.2 CAPEX and LCC

Table 6.21 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.21 CAPEX and Life-Cycle Costs for Portfolio 4: Deep Water Discharge (Palo Alto) and Extension to Guadalupe Slough at Sunnyvale

CAPEX		
Deep Water Discharge and Extension to Guadalupe Slough	$84.4M	
Life Cycle Costs	**30 year**	**100 year**
Deep Water Discharge and Extension to Guadalupe Slough	$322/AF	$227/AF

6.5 Morgan Hill

Included in all portfolios is a satellite AWPF at Morgan Hill. The only management option for disposal of the ROC from this plant is:

- Evaporation Ponds in Gilroy

Land availability in this area is limited but there is a parcel of land in Gilroy that may be used.

6.5.1 Morgan Hill: Evaporation Ponds

Description

The preferred method of brine disposal due to the plants small size and inland location is by means of a lined evaporation pond. Although a preliminary analysis was conducted on routing the ROC to discharge to the San Francisco Bay, this option was ultimately determined to be cost prohibitive due to the distance of the Morgan Hill AWPF from the Bay. A preliminary estimate placed the CAPEX of discharging to the San Francisco Bay to be twice the CAPEX of disposal through evaporation ponds. Additionally, pumping costs through the same sized pipes will be higher to the San Francisco Bay.

The amount of land required to dispose of the ROC by evaporation would be approximately 115 acres based on CWRMP 2025 and 2035 average monthly flows and the average evaporation rates for the area. A parcel of land suitable for the evaporation pond has been identified in Gilroy. This will be adjusted based on the more realistic costs per AF and potential reduction in surface area needs in case of the AWPF being able to produce higher ROC concentrations with improved technology. No costs for additional fill due to the high water table were included in this estimate. The preliminary design for this option is shown below in Table 6.22.

Table 6.22 Preliminary Design for Morgan Hill: Evaporation Pond in Gilroy

Design Item	Value	Units
ROC Flow	0.4	MGD
ROC Holding Tank	4	Hours holding time
ROC Holding Tank	67,000	gal
Pumps	3	number
Pumps	2+1	Service + Standby
Pump Power	50	HP
Pipeline Diameter	8	inches
Pipeline Length	58,600	feet
Pipeline Length	11.1	miles
Evaporation Pond	83	acres

6.5.1.1 CAPEX and LCC

Table 6.23 below shows the CAPEX and Life-Cycle cost estimates for this ROC management option. Pipeline routings, itemized CAPEX estimates, and LCC calculations are included in Appendices I, II, and III, respectively.

Table 6.23 CAPEX and Life-Cycle Costs for Morgan Hill: Evaporation Pond in Gilroy

CAPEX		
Evaporation Pond in Gilroy	$50.5M	
Life Cycle Costs	30 year	100 year
Evaporation Pond in Gilroy	$1103/AF	$647/AF

7. Conclusions/Summary

A summary of the costs of each ROC Management Option as well as recommendations for the next steps of this planning study are outlined in this section.

7.1 Summary of Options

Table 7.1 shows a summary of CAPEX and 30-year and 100-year LCC estimates for each Portfolio. Valley Water will evaluate these ROC Management costs together with the overall portfolio costs developed for the CWRMP. The selection of a future potable reuse project(s) will not only depend on costs, but also other factors including operational flexibility, treatment efficiency, environmental compliance, and governance; all of which will be outlined in CWRMP.

Table 7.1 Summary of CAPEX and LCC Estimates for ROC Management Options[25]

	CAPEX $M	30 YR LCC $/AF	100 YR LCC $/AF
Portfolio 1 at San Jose			
Blending after the Effluent Weir	$19.3M	$151	$128
Extension to Coyote Creek	$29.0M	$178	$145
Portfolio 2A at Palo Alto			
Blending with Palo Alto Effluent	$18.2M	$131	$112
Extension into San Francisco Bay	$35.7M	$178	$139
Deep Water Discharge	$75.3M	$294	$209
Portfolio 2B at Sunnyvale			
Extension to Guadalupe Slough	$38.3M	$189	$146
Portfolio 4 at Palo Alto and Sunnyvale			
Blending with Palo Alto Effluent and Extension to Guadalupe Slough	$41.8M	$199	$152
Extension into San Francisco Bay and Extension to Guadalupe Slough	$58.8M	$244	$179
Deep Water Discharge and Extension to Guadalupe Slough	$84.4M	$322	$227
Morgan Hill			
Evaporation Pond in Gilroy	$50.5M	$1103	$647

7.2 Recommendations for Next Steps for ROC Management

GHD recommends the following further actions as part of the ROC Management studies:

- Communication
  - Engage the regulators with consideration of compliance issues and keep them updated on the results of future treatment studies or analyses in the next steps of the project.

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[25] Land acquisition costs were not included in these estimates.

- Treatment
    - Additional treatment studies are currently being conducted, including those using floating wetlands as a treatment method. The results from these studies should be used to further develop and inform the recommendations for the ROC Management strategies.
    - It is assumed that a significant portion of the nickel and copper in the final effluent is chelated with an EDTA-like substance. However, if there is a significant portion that is not chelated, traditional treatment methods such as coagulation before MF/UF could reduce nickel and copper concentrations to NPDES compliance. It is recommended that the percentage of nickel and copper that is chelated be verified as well as if there is any cyclic variation of this percentage. This would require monthly sampling of the POTW discharge and analysis of total and dissolved copper and nickel.
    - Selenium removal can occur in a reductive environment. Since a denitrifying filter was included in preliminary design, it is recommended that a study of denitrification be performed to determine if a decrease in selenium concentration is observed.
- Risk Aversion
    - Stakeholders vary on the level of conservatism that should be used in determining feasibility. Statistical analysis for modeling of worst case events for the mass balance modeling can be done to predict the likelihood of violations to the existing or a future NPDES permit should it be required. This could be brought to discussions with regulators and stakeholders to better inform permit negotiations.
    - The current location proposed for the evaporation pond for the Morgan Hill AWPF is on a parcel of land owned by South County Regional Wastewater Authority. In the event that Valley Water is unable to use this land, another suitable plot for the evaporation pond closer to the Morgan Hill AWPF should be located.
    - Since available data was limited, the estimated size for the evaporation pond at the Gilroy facility was determined based on evapotranspiration data for the city of Gilroy. It is advisable that site specific pan evaporation data be collected at the proposed site to verify the required area.
    - Zinc was eliminated from consideration before the mass balance modeling due to its low attenuation factor. A further look at newer data may be necessary. If the concentration of zinc is found to be problematic, mass balance modeling should be performed.

Research and Special Studies:

- For contaminants that were partially removed in the treatment train, particularly fipronil and imidacloprid, source control measures are likely needed to reduce the inflow of these chemicals to POTW.
- For metals and PFAS, including Perfluorooctanoic Acid and Perfluorooctanesulfonic Acid, which had limited removal in the treatment train, additional management options should be considered.
- Nature-based solutions that reduce nutrient loads more effectively, particularly in the winter, should be explored. Pilot studies at Oro Loma are ongoing and will provide estimates of nutrient and other contaminant removal.

- Develop a monitoring strategy to assess water quality changes (chemistry and toxicity) before and after ROC discharge is implemented. Monitoring effects in receiving habitats (e.g., baylands) may also be needed.
- Where possible, coordinate treatment options with baylands restoration activities that include horizontal levees or creek mouths.
- Implement a robust monitoring program to track restoration progress and identify unforeseen consequences (before and after implementation monitoring).
- Account for constraints when designing bayland discharge options, including salinity, contaminant concentration, terrestrial food web connectivity, and mosquito abatement and invasive species management.

Appendix I: Proposed Pipeline Alignments for ROC Management Options

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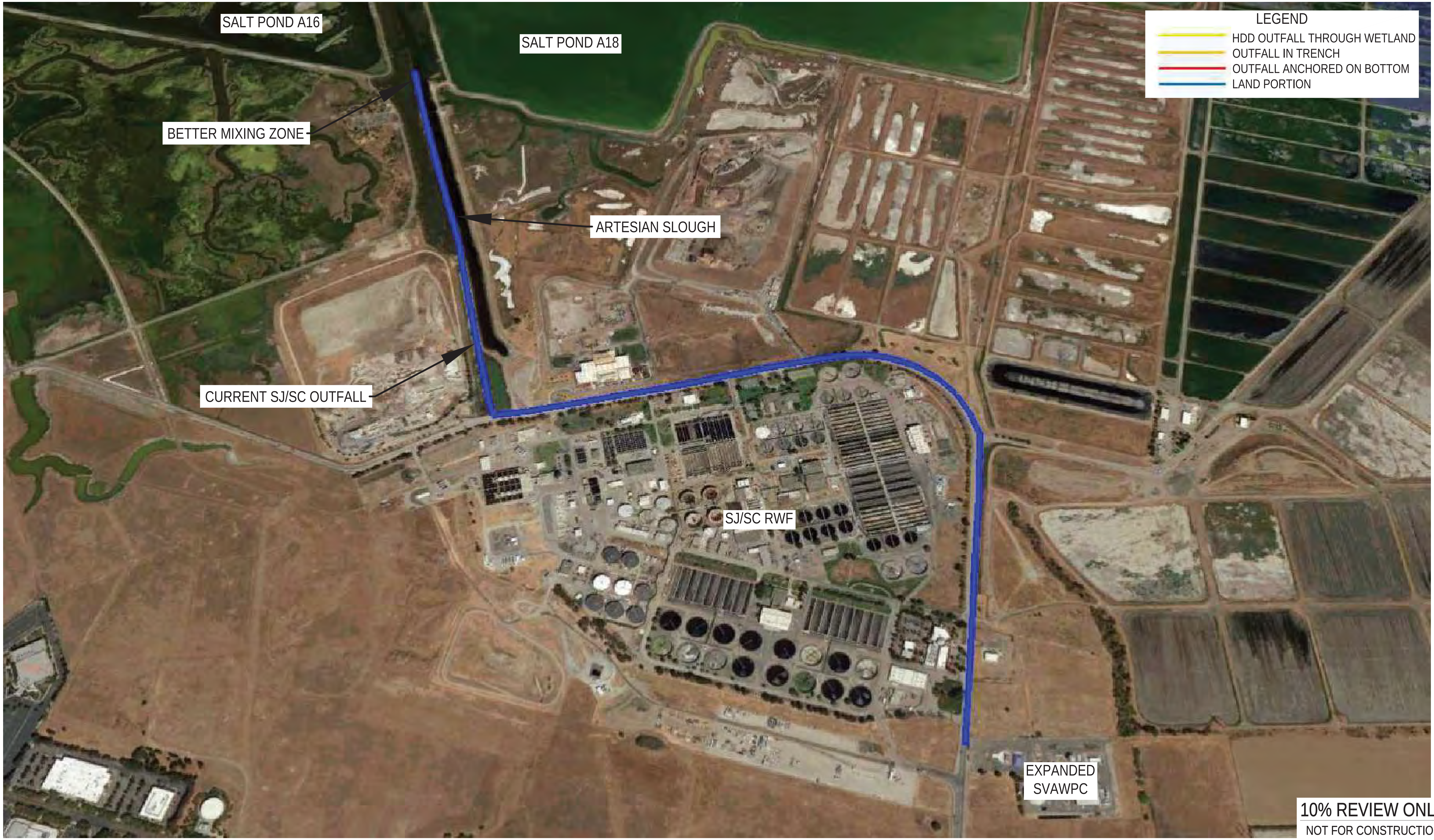

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Title PORTFOLIO 1 - BLENDING AFTER THE EFFLUENT WEIR
Project No. 11110722
Original Size ANSI D
Sheet No. C-101
Sheet 2 of 22

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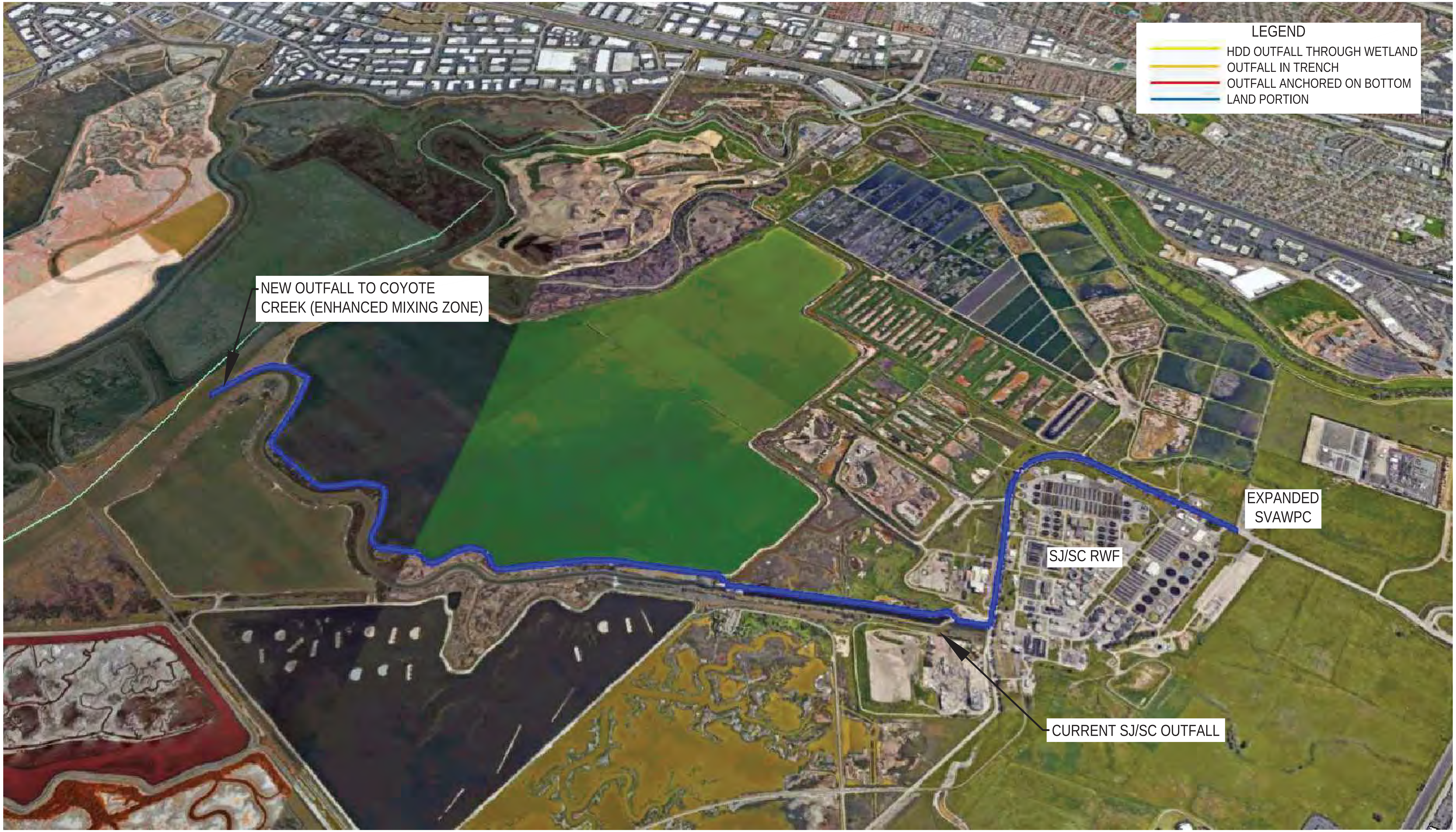
LEGEND
HDD OUTFALL THROUGH WETLAND
OUTFALL IN TRENCH
OUTFALL ANCHORED ON BOTTOM
LAND PORTION
NEW OUTFALL TO COYOTE CREEK (ENHANCED MIXING ZONE)
EXPANDED SVAWPC
SJ/SC RWF
CURRENT SJ/SC OUTFALL

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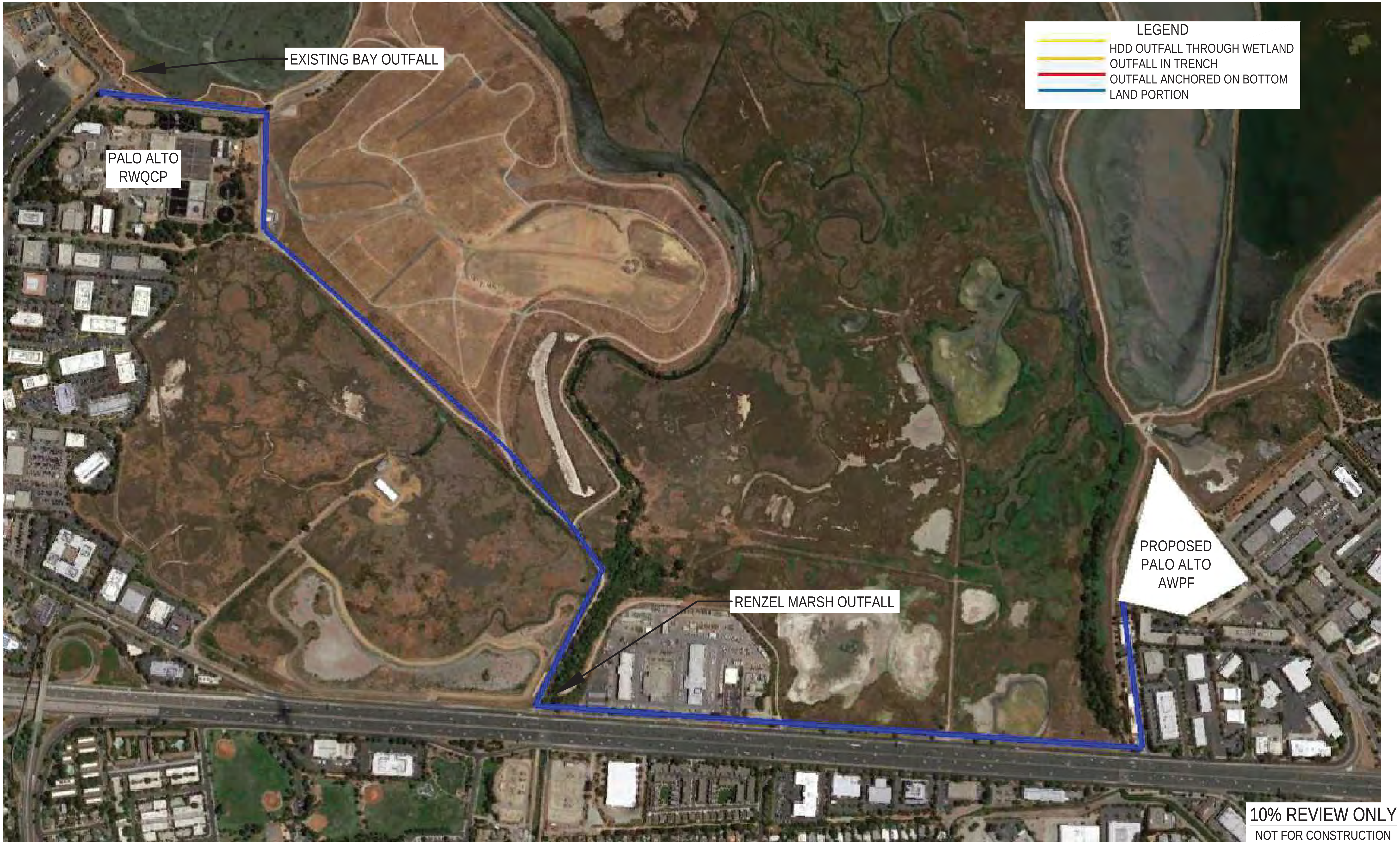

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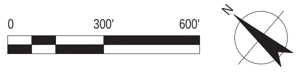

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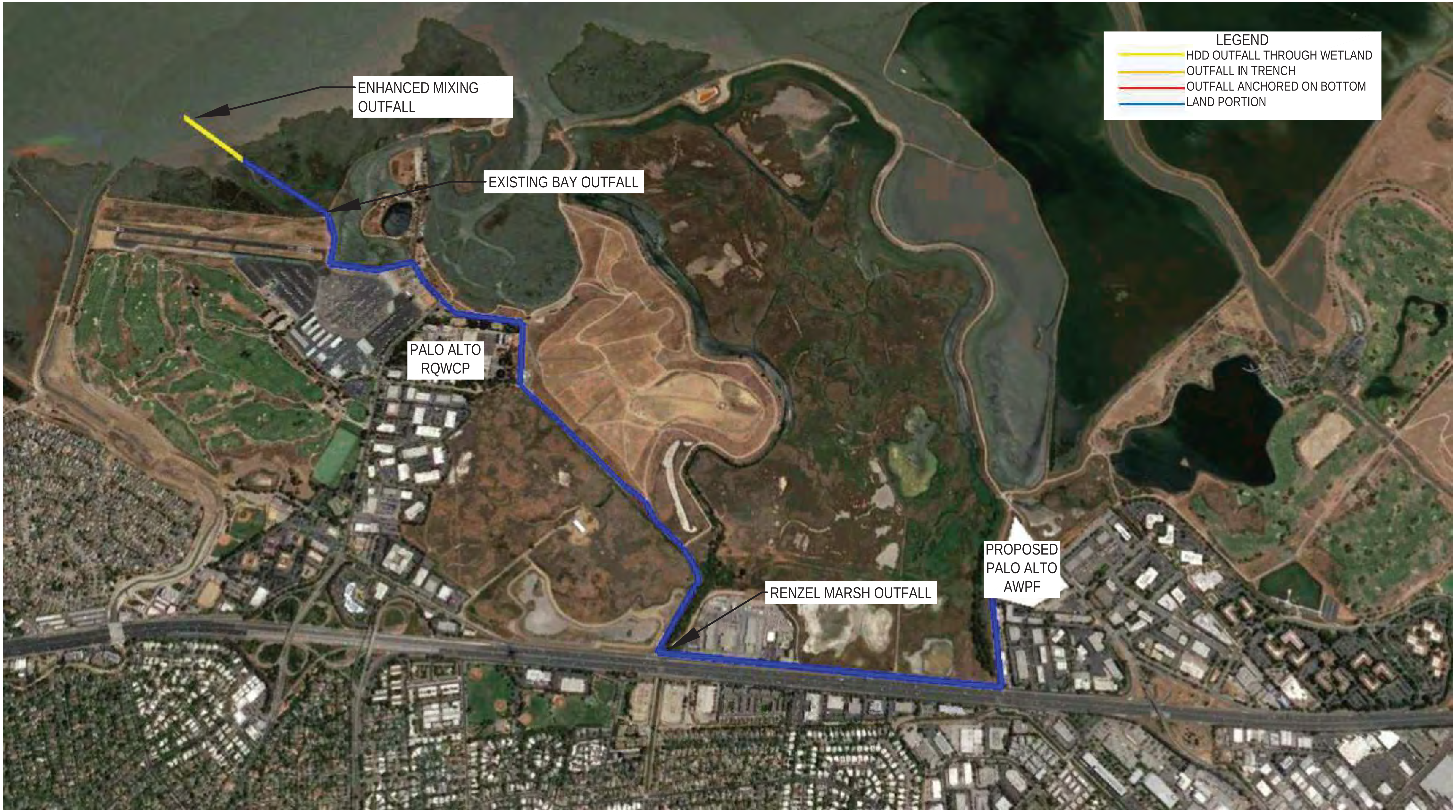

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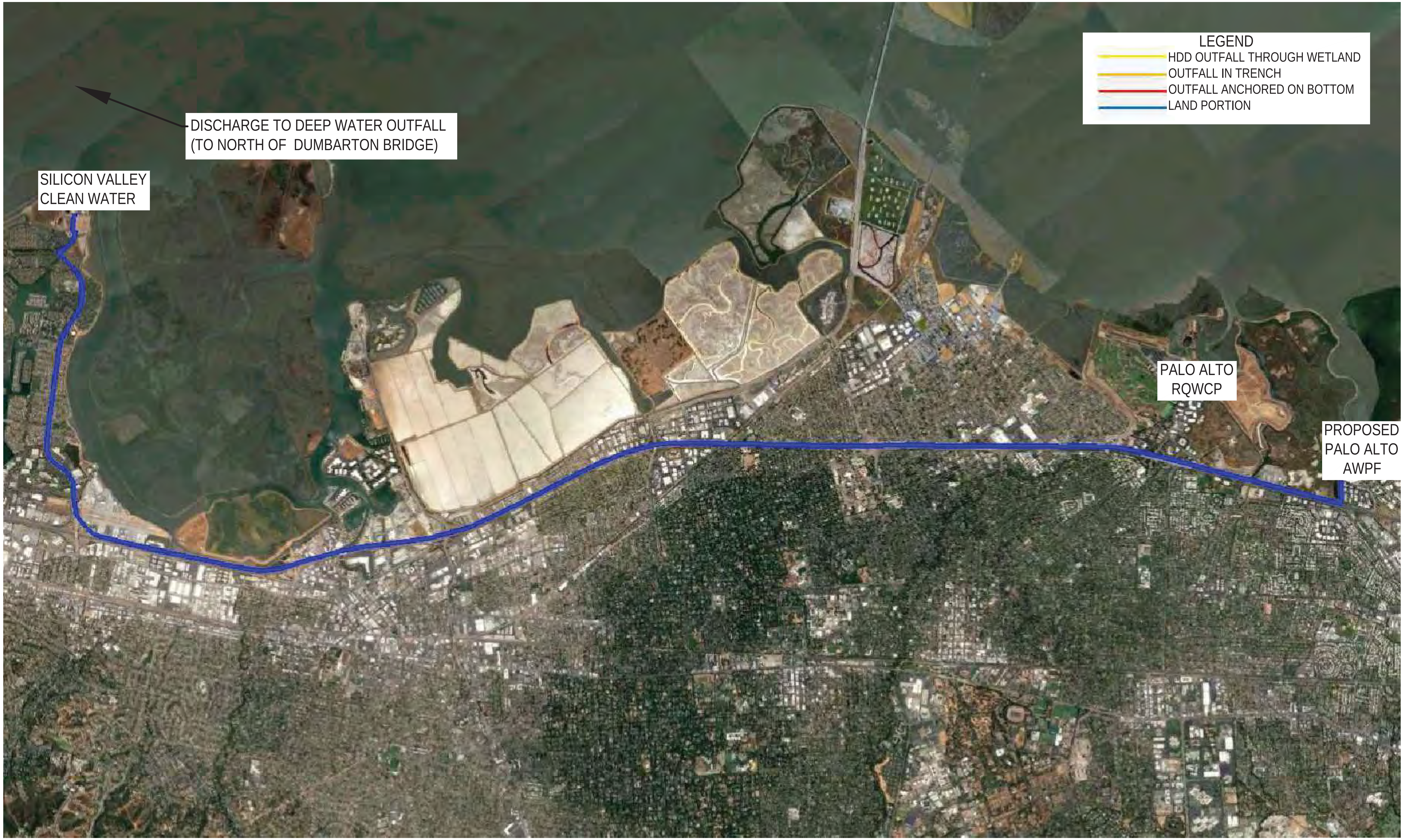
LEGEND
HDD OUTFALL THROUGH WETLAND
OUTFALL IN TRENCH
OUTFALL ANCHORED ON BOTTOM
LAND PORTION
DISCHARGE TO DEEP WATER OUTFALL (TO NORTH OF DUMBARTON BRIDGE)
SILICON VALLEY CLEAN WATER
PALO ALTO RQWCP
PROPOSED PALO ALTO AWPF

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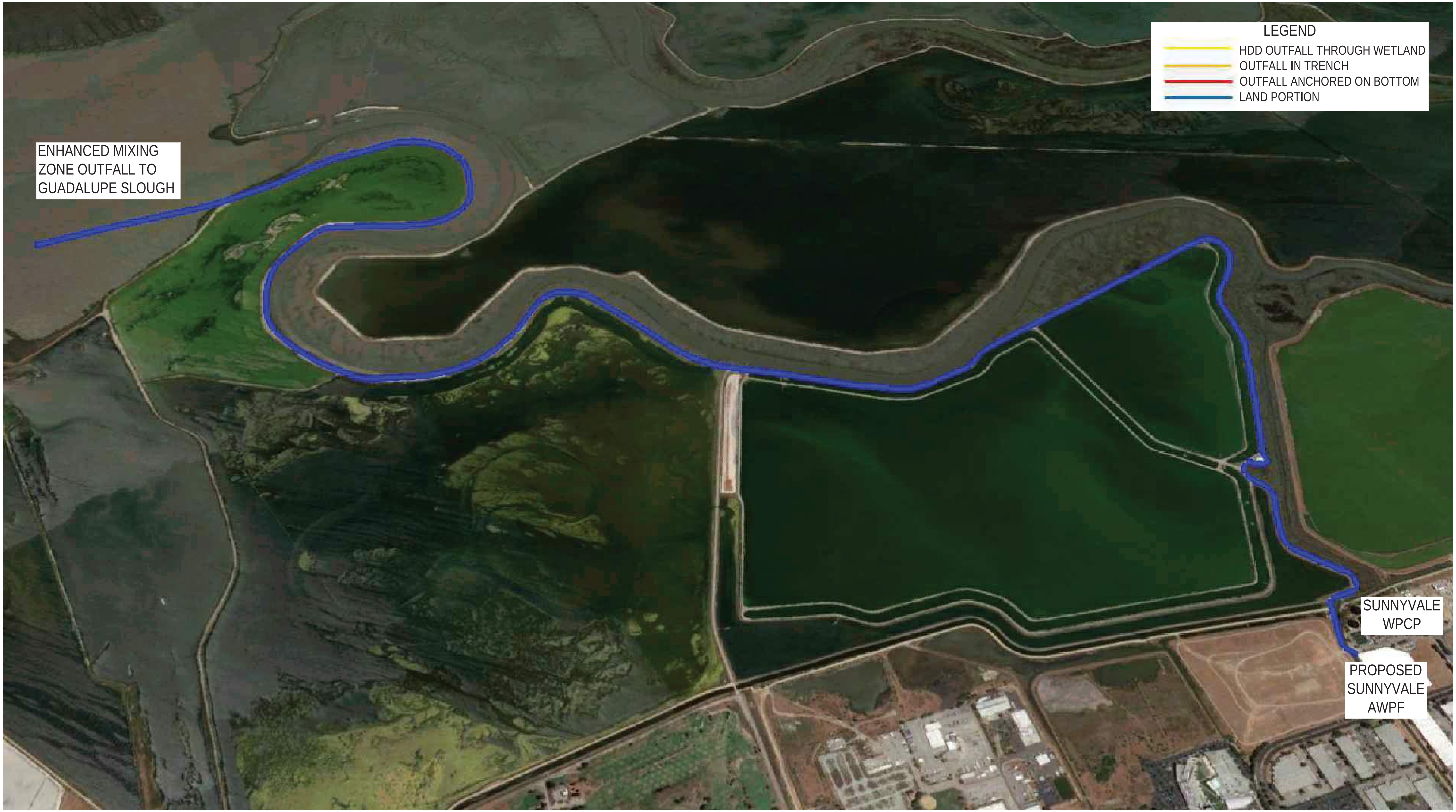
LEGEND
HDD OUTFALL THROUGH WETLAND
OUTFALL IN TRENCH
OUTFALL ANCHORED ON BOTTOM
LAND PORTION
ENHANCED MIXING ZONE OUTFALL TO GUADALUPE SLOUGH
SUNNYVALE WPCP
PROPOSED SUNNYVALE AWPF

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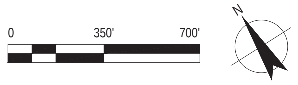

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Client VALLEY WATER
Project RO CONCENTRATE MANAGEMENT PLAN
Title PORTFOLIO 2B - EXTENSION TO GUADALUPE SLOUGH

Project No. 11110722
Original Size ANSI D
Sheet No. C-106
Sheet 7 of 22

Plot Date: 16 June 2020 - 2:59 PM
Plotted By: Alexis Zoffreo
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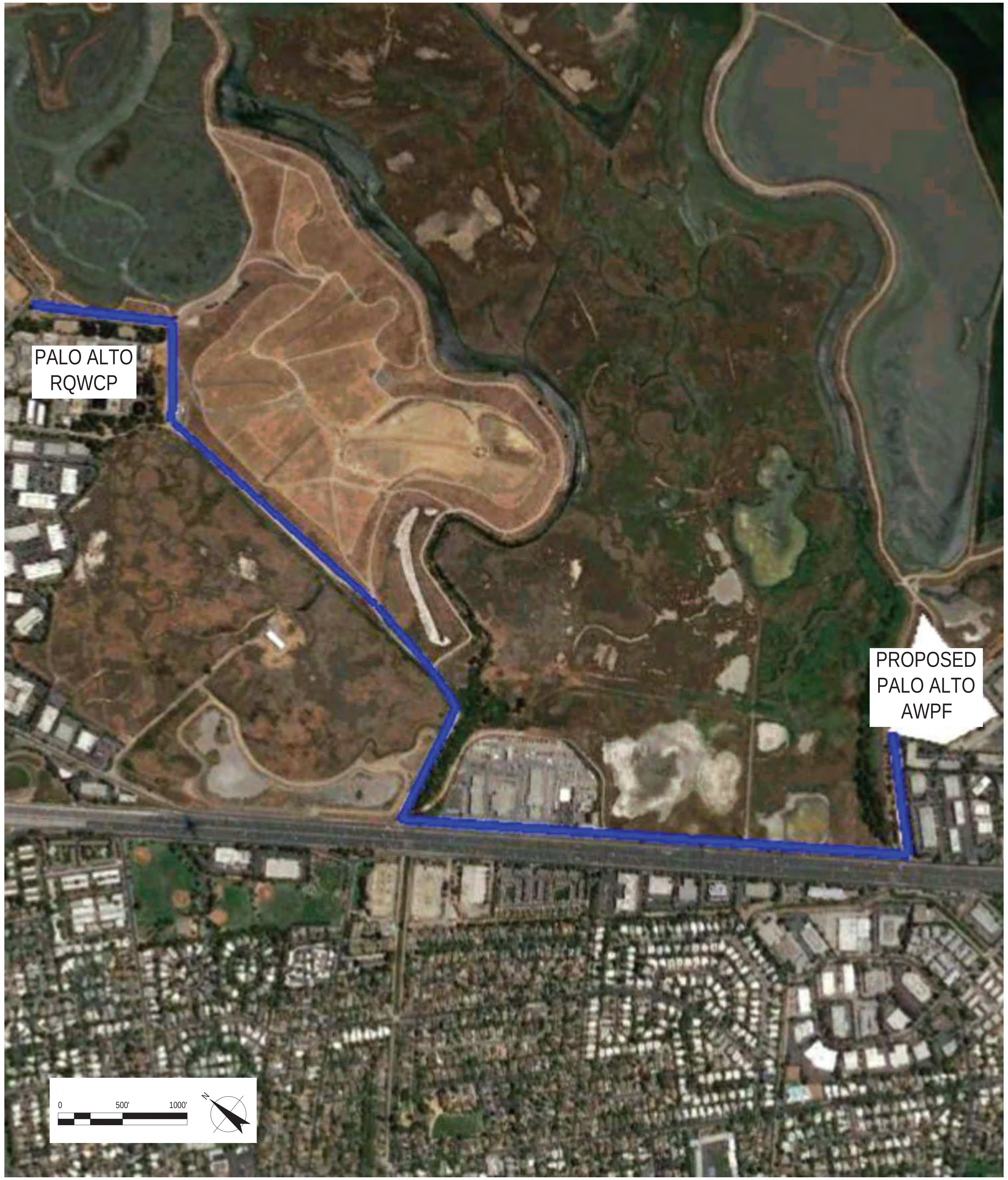

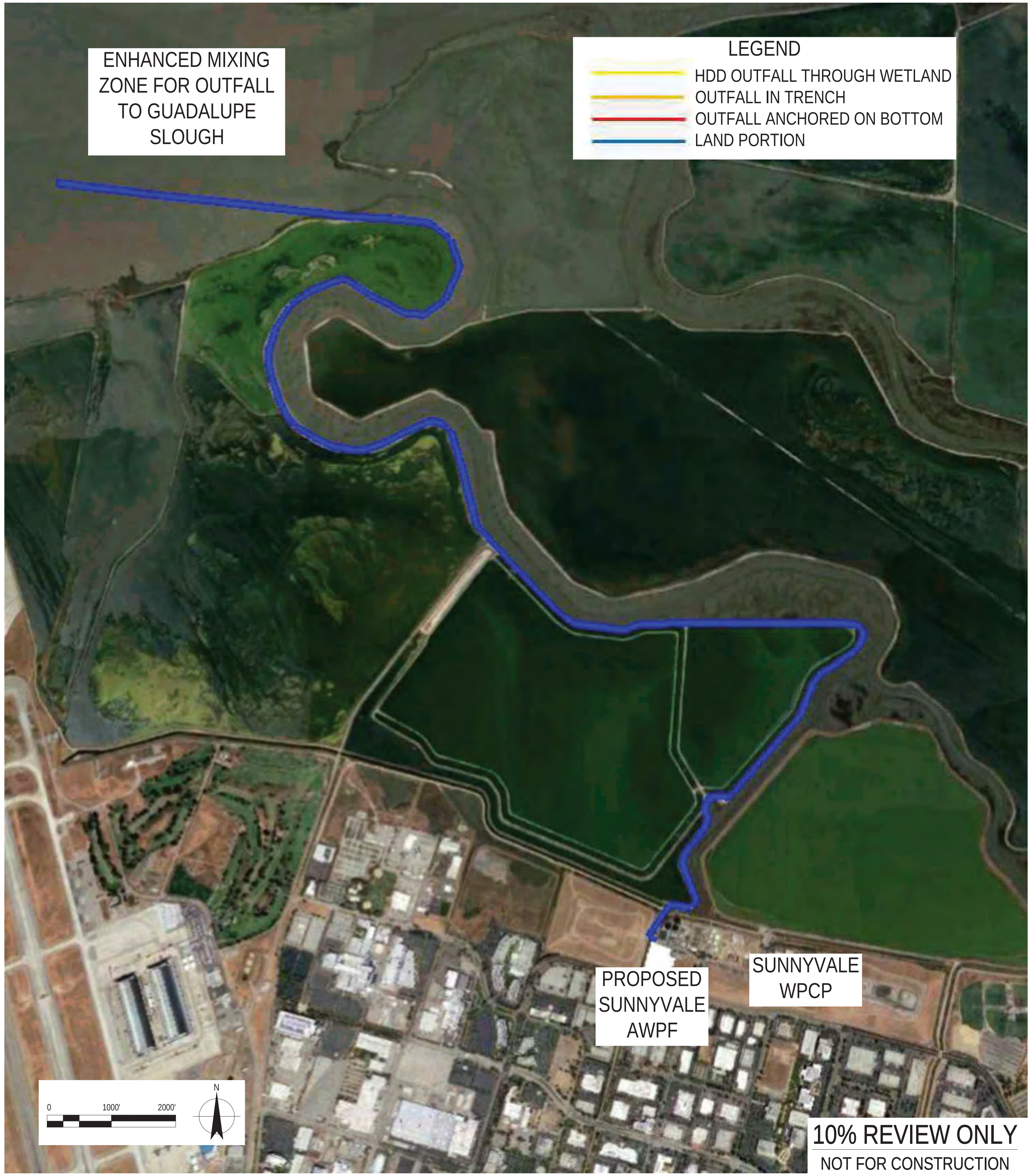
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LEGEND
HDD OUTFALL THROUGH WETLAND
OUTFALL IN TRENCH
OUTFALL ANCHORED ON BOTTOM
LAND PORTION
PROPOSED SUNNYVALE AWPF
SUNNYVALE WPCP
0
1000'
2000'
N

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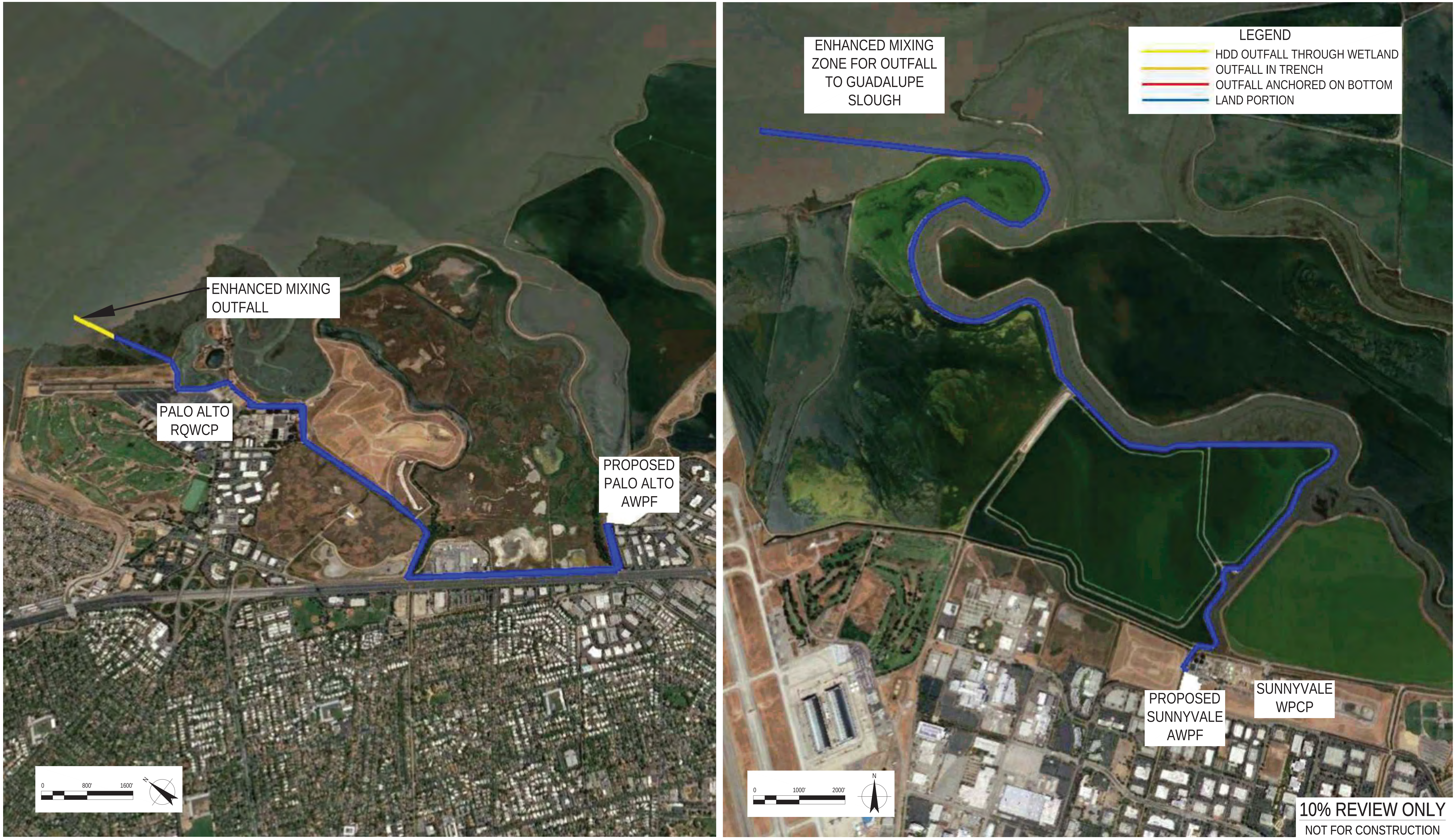
Client VALLEY WATER
Project RO CONCENTRATE MANAGEMENT PLAN
Title PORTFOLIO 4 - BLENDING WITH PALO ALTO EFFLUENT AND EXTENSION TO GUADALUPE SLOUGH AT SUNNYVALE
Project No. 11110722
Original Size ANSI D
Sheet No. C-107
Sheet 8 of 22



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Client VALLEY WATER
Project RO CONCENTRATE MANAGEMENT PLAN
Title PORTFOLIO 4 - EXTENSION INTO SF BAY (PALO ALTO) AND EXTENSION TO GUADALUPE SLOUGH (SUNNYVALE)
Project No. 11110722
Original Size ANSI D
Sheet No. C-108
Sheet 9 of 22

Plot Date: 16 June 2020 - 2:59 PM
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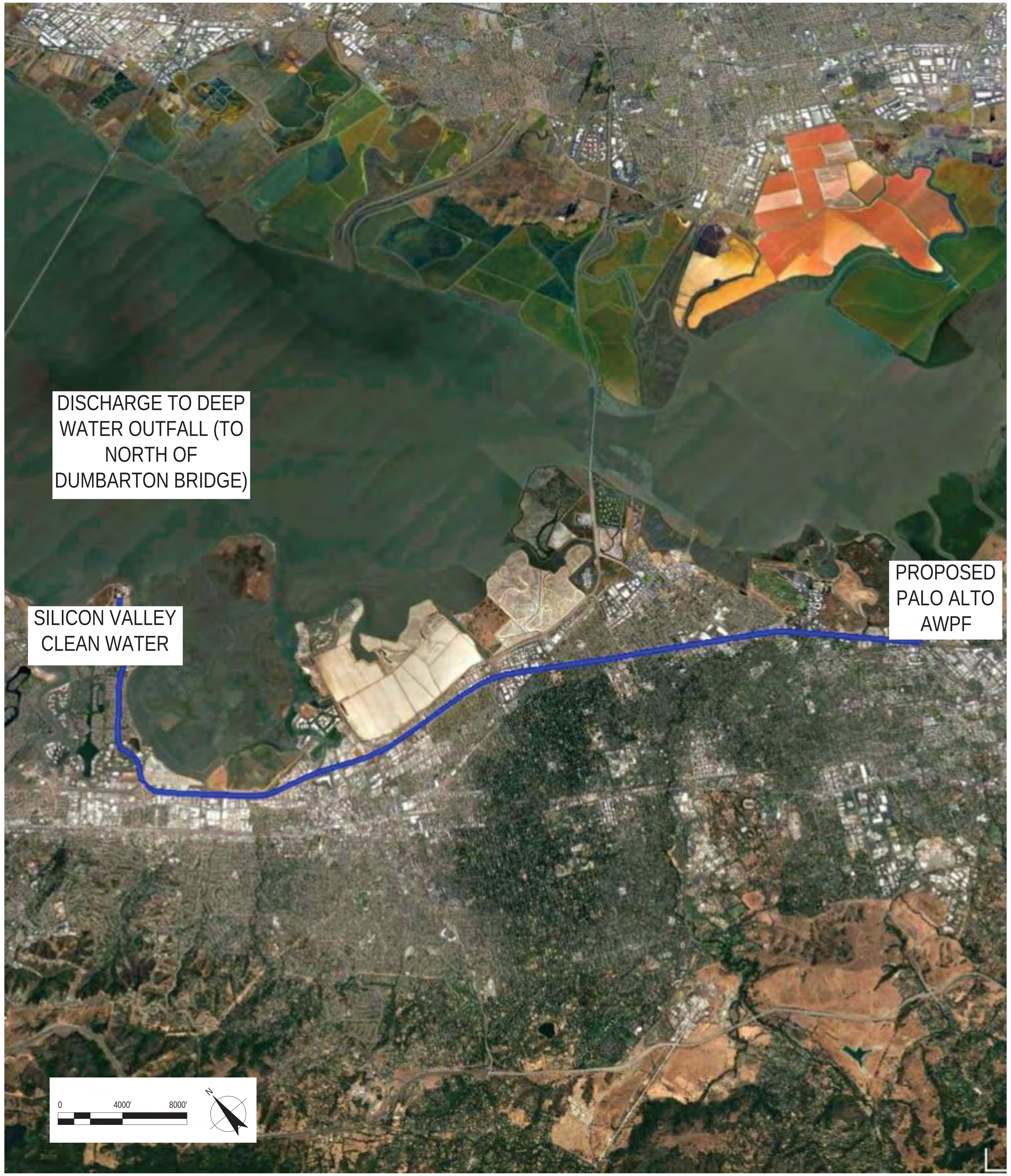
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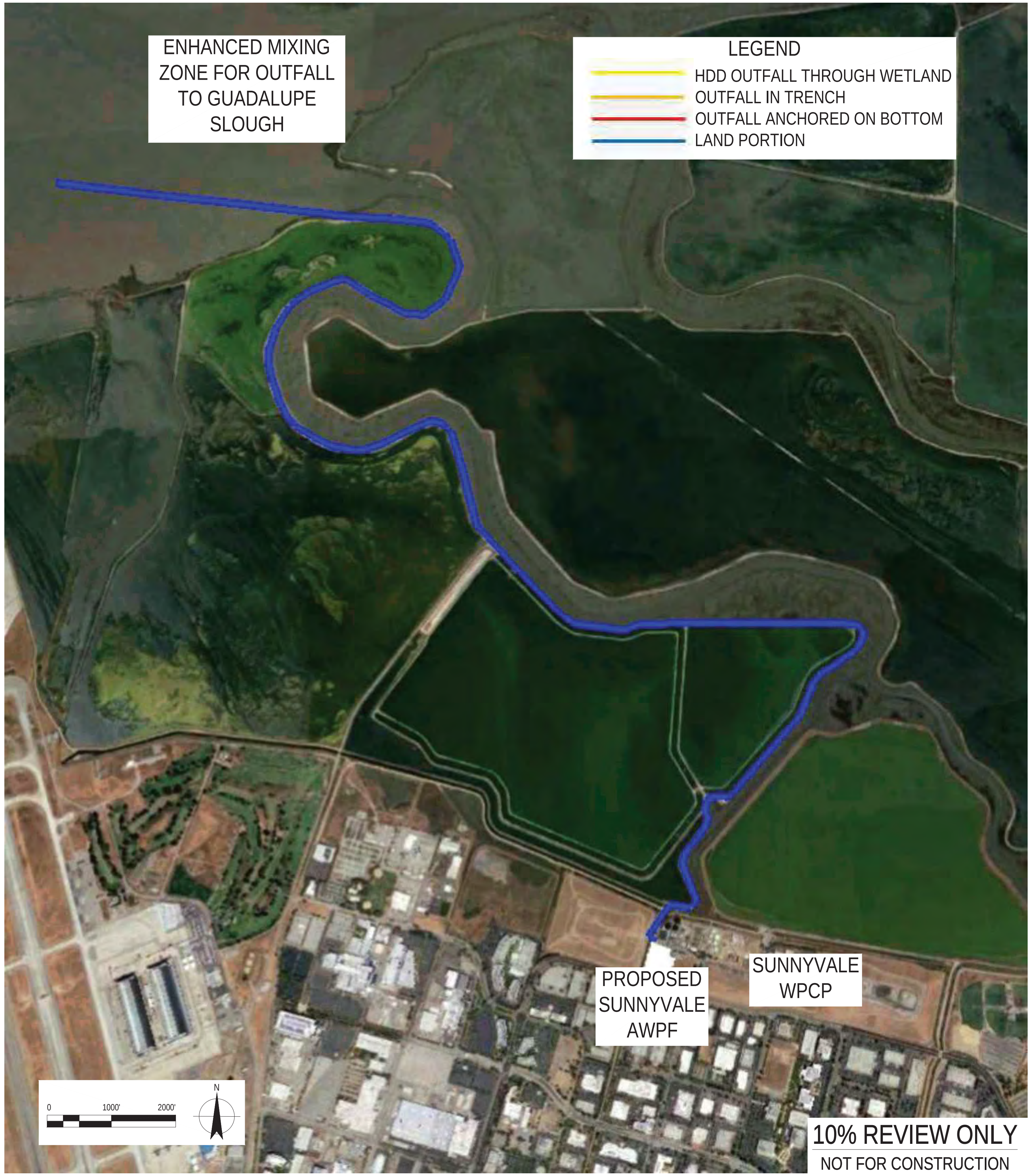
SILICON VALLEY CLEAN WATER
PROPOSED PALO ALTO AWPF
0
4000'
8000'
N


ENHANCED MIXING ZONE FOR OUTFALL TO GUADALUPE SLOUGH
LEGEND
HDD OUTFALL THROUGH WETLAND
OUTFALL IN TRENCH
OUTFALL ANCHORED ON BOTTOM
LAND PORTION
PROPOSED SUNNYVALE AWPF
SUNNYVALE WPCP
0
1000'
2000'
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Project RO CONCENTRATE MANAGEMENT PLAN
Title PORTFOLIO 4 - DEEP WATER OUTFALL (PALO ALTO) AND EXTENSION TO GUADALUPE SLOUGH (SUNNYVALE)
Project No. 11110722
Original Size ANSI D
Sheet No. C-109
Sheet 10 of 22

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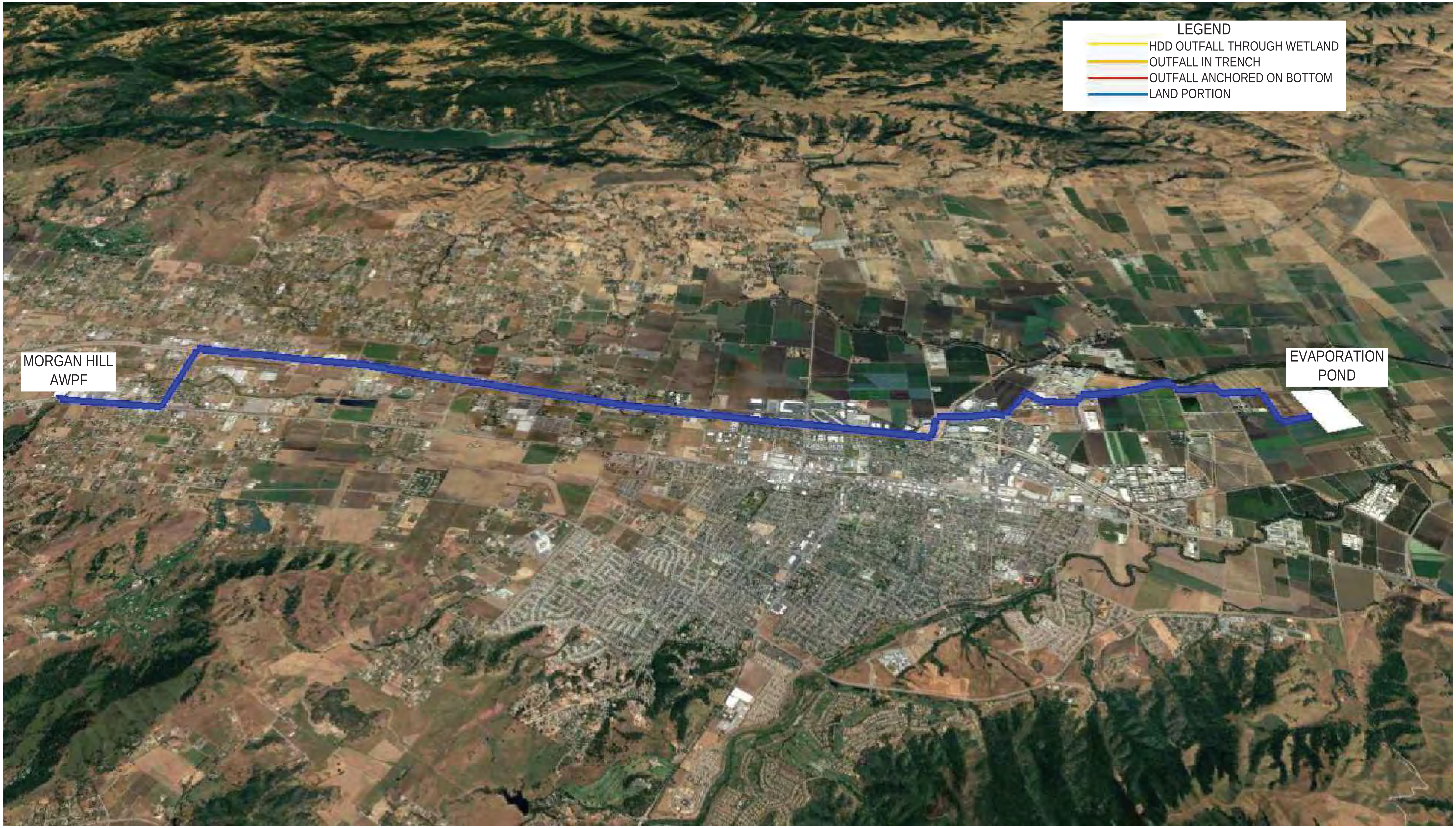

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Client VALLEY WATER
Project RO CONCENTRATE MANAGEMENT PLAN
Title MORGAN HILL - EVAPORATION POND IN GILROY
Project No. 11110722
Original Size ANSI D
Sheet No. C-110
Sheet 11 of 22

Plot Date: 16 June 2020 - 3:00 PM
Plotted By: Alexis Zoffreo
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Appendix II: CAPEX Estimates for ROC Management Options

San Jose (New Outfall) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
4.24 mgd ROC line - 18" 50 psi HDPE (Installed Cost)	$ 250.00	9536	LF	$ 2,384,000
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	$ -
Dewatering	$ 60.00	3536	LF	$ 212,160
Pavement Replacement (4 ft wide)	$ 40.00	6000	LF	$ 240,000
Shoring & Trench Safety	$ 22.00	9536	LF	$ 209,800
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	8	EA	$ 68,800
Excavation and Offhauling	$ 30.00	695	CY	$ 20,900
Mobilization & Demobilization	6%	1	LS	$ 186,900
Temporary Traffic Control		1	LS	$ 96,400
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 62,300
Survey and Staking	1%	1	LS	$ 31,100
Total Unit Cost/LF	**$ 368**			
Total Pipeline Cost				**$ 3,512,400**

Full Itemized Pump Station Cost Estimate

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 50 HP, 2 duty/1 standby	$ 55,900
Motors	3x	$ 5,600
16" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 63,600
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material costs	$ 495,300
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 670,400**

San Jose (New Outfall) ROC Management Cost Estimate

Item	Description		Total Cost
Discharge Pipeline	18", 50 psi pressure rating HDPE Pipe		$ 3,512,400
ROC Pump Station	See Itemized List		$ 670,400
Outfall Diffuser	In stream - multiport diffuser		$ 500,000
ROC Holding Tank	0.75 MG, 4 hrs holding time		$ 1,550,000
SUBTOTAL (CONSTRUCTION)			$ 6,232,800
Contingency		30%	$ 1,869,800
SUBTOTAL			$ 8,102,600
Tax on Materials		9%	$ 364,600
Overhead and Profit		12%	$ 972,300
Estimated Total Construction Costs			$ 9,439,500
Owner's Reserve for Change Orders		15%	$ 1,415,900
Engineering Services (Design)		15%	$ 1,415,900

Construction Management	13%	$	1,227,100
Engineering Services During Construction	12%	$	1,132,700
SUBTOTAL		$	14,631,100
Treatment for CECs (Optional)		$	2,120,000
Treatment for Nutrients (Optional)		$	2,544,000
Total Cost		**$**	**19,295,000**

San Jose (Coyote Creek) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
4.24 mgd ROC line - 18" 50 psi HDPE (Installed Cost)	$ 250.00	19986	LF	$ 4,996,500
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	$ -
Dewatering	$ 60.00	13586	LF	$ 815,160
Pavement Replacement (4 ft wide)	$ 40.00	6400	LF	$ 256,000
Shoring & Trench Safety	$ 22.00	19986	LF	$ 439,700
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	16	EA	$ 137,600
Excavation and Offhauling	$ 30.00	1457	CY	$ 43,700
Mobilization & Demobilization	6%	1	LS	$ 398,700
Temporary Traffic Control		1	LS	$ 102,700
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 132,900
Survey and Staking	1%	1	LS	$ 66,400
Total Unit Cost/LF	**$ 370**			
Total Pipeline Cost				**$ 7,389,360**

Full Itemized Pump Station Cost Estimate

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 100 HP, 2 duty/1 standby	$ 97,800
Motors	3x	$ 11,300
16" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 63,600
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 100 HP VFDs	1x	$ 50,000
Mechanical Installation	3x material costs	$ 698,100
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 940,800**

San Jose (Coyote Creek) Portfolio 1 ROC Management Cost Estimate

Item	Description	Total Cost
Discharge Pipeline	18", 50 psi pressure rating HDPE Pipe	$ 7,389,360
ROC Pump Station	See Itemized List	$ 940,800
Outfall Diffuser	In stream - multiport diffuser	$ 500,000
ROC Holding Tank	0.75 MG, 4 hrs holding time	$ 1,550,000
SUBTOTAL (CONSTRUCTION)		$ 10,380,160
Contingency	30%	$ 3,114,000
SUBTOTAL		$ 13,494,160
Tax on Materials	9%	$ 607,200
Overhead and Profit	12%	$ 1,619,300
Estimated Total Construction Costs		$ 15,720,660
Owner's Reserve for Change Orders	15%	$ 2,358,100
Engineering Services (Design)	15%	$ 2,358,100
Construction Management	13%	$ 2,043,700

Engineering Services During Construction	12%	$	1,886,500
SUBTOTAL		$	24,367,100
Treatment for CECs (Optional)		$	2,120,000
Treatment for Nutrients (Optional)		$	2,544,000
	Total Cost	**$**	**29,031,000**

Palo Alto (Existing Outfall) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
4.24 mgd ROC line - 18" 50 psi HDPE (Installed Cost)	$ 225.00	10849	LF	$ 2,441,000
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	$ -
Dewatering	$ 60.00	0	LF	$ -
Pavement Replacement (4 ft wide)	$ 40.00	10849	LF	$ 434,000
Shoring & Trench Safety	$ 22.00	10849	LF	$ 238,700
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	9	EA	$ 77,400
Excavation and Offhauling	$ 30.00	876	CY	$ 26,280
Mobilization & Demobilization	6%	1	LS	$ 191,500
Temporary Traffic Control	5%	1	LS	$ 159,600
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 63,800
Survey and Staking	1%	1	LS	$ 31,900
Total Unit Cost/LF	**$ 338**			
Total Pipeline Cost				**$ 3,664,180**

Full Itemized Pump Station Cost Estimate

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 50 HP, 2 duty/1 standby	$ 55,900
Motors	3x	$ 5,600
12" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material costs	$ 398,100
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 540,800**

Palo Alto at Los Altos (Existing Outfall) Portfolio 2A ROC Management Conceptual Cost Estimate

Item	Description	Total Cost
Discharge Pipeline	18", 50 psi pressure rating HDPE Pipe	$ 3,664,180
ROC Pump Station	See Itemized List	$ 540,800
ROC Holding Tank	0.75 MG, 4 hrs holding time	$ 1,550,000
SUBTOTAL (CONSTRUCTION)		$ 5,754,980
Contingency	30%	$ 1,726,500
SUBTOTAL		$ 7,481,480
Tax on Materials	9%	$ 336,700
Overhead and Profit	12%	$ 897,800
Estimated Total Construction Costs		$ 8,715,980
Owner's Reserve for Change Orders	15%	$ 1,307,400
Engineering Services (Design)	15%	$ 1,307,400
Construction Management	13%	$ 1,133,100

Engineering Services During Construction	12%	$	1,045,900
SUBTOTAL		$	13,509,800
Treatment for CECs (Optional)		$	2,120,000
Treatment for Nutrients (Optional)		$	2,544,000
	Total Cost	**$**	**18,174,000**

Palo Alto (1000 LF Into Bay) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
4.24 mgd ROC line - 18" 50 psi HDPE (Installed Cost)	$ 225.00	14563	LF	$ 3,276,700
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	
Dewatering	$ 60.00	1821	LF	$ 109,260
Pavement Replacement (4 ft wide)	$ 40.00	12742	LF	$ 509,700
Shoring & Trench Safety	$ 22.00	14563	LF	$ 320,400
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	12	EA	$ 103,200
Excavation and Offhauling	$ 30.00	1177	CY	$ 35,310
Mobilization & Demobilization	6%	1	LS	$ 259,156
Temporary Traffic Control		1	LS	$ 188,900
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 86,385
Survey and Staking	1%	1	LS	$ 43,193
Total Unit Cost/LF	**$ 339**			
Total Pipeline Cost				**$ 4,932,203**

Palo Alto Deep Water Outfall ROC Conveyance Pipeline Cost Estimate (In-Water Section)

Item	Unit Cost	Quantity	Unit	Total Cost
Mobilization Horiz Directional Drill (HDD) Equipment	$ 1,250,000	1	LS	$ 1,250,000
Staging Area on Levee (HDD Entry Pit)	$ 250,000	1	LS	$ 250,000
18" HDPE Outfall Pipe Installed thru Wetland (HDD)	$ 2,500	1,000	LF	$ 2,500,000
Exit Pit, Connect b/w HDD and Weighted Outfall	$ 500,000	1	LS	$ 500,000
Mobilization of Dredges and Barges (Marine Equip)	$ 2,000,000	0	LS	$ -
Marine Cut Trench (w/ Hyd. Dredge Equip to -20)	$ 2,000	0	LF	$ -
18" HDPE Outfall Installed w/ Concrete Weights	$ 2,500	0	LF	$ -
Diffuser at End of Outfall (includes piling)	$ 1,500,000	1	LS	$ 1,500,000
Bonds and Insurance	2%	1	LS	$ 120,000
Marine Survey / Navigation Control	1%	1	LS	$ 60,000
Total Unit Cost/LF	**$ 6,180**			
Total In Water Pipeline Cost				**$ 6,180,000**

Full Itemized Pump Station Cost Estimate

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 50 HP, 2 duty/1 standby	$ 55,900
Motors	3x	$ 5,600

12" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material costs	$ 398,100
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	$ 540,800

Palo Alto (1000 LF Into Bay) ROC Management Conceptual Cost Estimate

Item	Description	Total Cost
Discharge Pipeline (Land Portion)	18", 50 psi pressure rating HDPE Pipe	$ 4,932,203
Discharge Pipeline (Marine Portion)	18", 50 psi pressure rating HDPE Pipe	$ 6,180,000
ROC Pump Station	See Itemized List	$ 540,800
ROC Holding Tank	0.75 MG, 4 hrs holding time	$ 1,550,000
SUBTOTAL (CONSTRUCTION)		$ 13,203,003
Contingency	30%	$ 3,960,900
SUBTOTAL		$ 17,163,903
Tax on Materials	9%	$ 772,400
Overhead and Profit	12%	$ 2,059,700
Estimated Total Construction Costs		$ 19,996,003
Owner's Reserve for Change Orders	15%	$ 2,999,400
Engineering Services (Design)	15%	$ 2,999,400
Construction Management	13%	$ 2,599,500
Engineering Services During Construction	12%	$ 2,399,500
SUBTOTAL		$ 30,993,800
Treatment for CECs (Optional)		$ 2,120,000
Treatment for Nutrients (Optional)		$ 2,544,000
	Total Cost	$ 35,658,000

Palo Alto SVCW ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
4.24 mgd ROC line - 20" 160 psi HDPE (Installed Cost)	$ 250.00	70257	LF	$ 17,564,300
Additional Cost for High Pressure Pipe	$ 0.70	2,025,509	LB	$ 1,417,900
Dewatering	$ 60.00	0	LF	$ -
Pavement Replacement (4 ft wide)	$ 40.00	70257	LF	$ 2,810,300
Shoring & Trench Safety	$ 22.00	70257	LF	$ 1,545,700
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	54	EA	$ 464,400
Excavation and Offhauling	$ 30.00	6258	CY	$ 187,740
Mobilization & Demobilization	6%	1	LS	$ 1,428,200
Temporary Traffic Control	5%	1	LS	$ 1,190,100
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 476,100
Survey and Staking	1%	1	LS	$ 238,000
Total Unit Cost/LF	**$ 389**			
Total Pipeline Cost				**$ 27,322,740**

Full Itemized Pump Station Cost Estimate

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 300 HP, 2 duty/1 standby	$ 148,700
Motors	3x	$ 22,100
12" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 300 HP VFDs	1x	$ 89,200
Mechanical Installation	3x material costs	$ 903,600
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 1,214,800**

Palo Alto SVCW ROC Management Cost Estimate

Item	Description	Total Cost
Discharge Pipeline	20", 50 psi pressure rating HDPE Pipe	$ 27,322,740
ROC Pump Station	See Itemized List	$ 1,214,800
ROC Holding Tank	0.75 MG, 4 hrs holding time	$ 1,550,000
SUBTOTAL (CONSTRUCTION)		$ 30,087,540
Contingency	30%	$ 9,026,300
SUBTOTAL		$ 39,113,840
Tax on Materials	9%	$ 1,760,100
Overhead and Profit	12%	$ 4,693,700
Estimated Total Construction Costs		$ 45,567,640
Owner's Reserve for Change Orders	15%	$ 6,835,100
Engineering Services (Design)	15%	$ 6,835,100
Construction Management	13%	$ 5,923,800
Engineering Services During Construction	12%	$ 5,468,100
SUBTOTAL		$ 70,629,700

Treatment for CECs (Optional)	$ 2,120,000
Treatment for Nutrients (Optional)	$ 2,544,000
Total Cost	**$ 75,294,000**

Sunnyvale (Guadalupe Slough) ROC Conveyance Pipeline Cost Estimate

Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
4.24 mgd ROC line - 18" 64 psi HDPE (Installed Cost)	$ 225.00	32760	LF	$ 7,371,000
Additional Cost for High Pressure Pipe	$ 0.70	104177	LB	$ 72,924
Dewatering	$ 60.00	32760	LF	$ 1,965,600
Pavement Replacement (4 ft wide)	$ 40.00	0	LF	$ -
Shoring & Trench Safety	$ 22.00	32760	LF	$ 720,700
18" Butterfly Valve (every 0.25 miles)	$ 8,600.00	25	EA	$ 215,000
Excavation and Offhauling	$ 30.00	2647	CY	$ 79,410
Mobilization & Demobilization	6%	1	LS	$ 620,700
Temporary Traffic Control		0	LS	
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 206,900
Survey and Staking	1%	1	LS	$ 103,500
Total Unit Cost/LF	**$ 347**			
Total Pipeline Cost				**$ 11,355,734**

Full Itemized Pump Station Cost Estimate

Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 150 HP, 2 duty/1 standby	$ 109,400
Motors	3x	$ 16,200
12" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 150 HP VFDs	1x	$ 63,800
Mechanical Installation	3x material costs	$ 691,800
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 932,400**

Sunnyvale (Guadalupe Slough) ROC Management Cost Estimate

Item	**Description**	**Total Cost**
Discharge Pipeline	18", 50 psi pressure rating HDPE Pipe	$ 11,355,734
ROC Pump Station	See Itemized List	$ 932,400
Outfall Diffuser	In stream- multiport diffuser	$ 500,000
ROC Holding Tank	0.75 MG, 4 hrs holding time	$ 1,550,000
SUBTOTAL (CONSTRUCTION)		$ 14,338,134
Contingency	30%	$ 4,301,400
SUBTOTAL		$ 18,639,534
Tax on Materials	9%	$ 838,800
Overhead and Profit	12%	$ 2,236,700
Estimated Total Construction Costs		$ 21,715,034
Owner's Reserve for Change Orders	15%	$ 3,257,300
Engineering Services (Design)	15%	$ 3,257,300
Construction Management	13%	$ 2,823,000

Engineering Services During Construction	12%	$ 2,605,800
SUBTOTAL		$ 33,658,400
Treatment for CECs (Optional)		$ 2,120,000
Treatment for Nutrients (Optional)		$ 2,544,000
	Total Cost	**$ 38,322,000**

Palo Alto (Existing Outfall) ROC Conveyance Pipeline Cost Estimate

Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
2.47 mgd ROC line - 14" 50 psi HDPE (Installed Cost)	$ 175.00	10849	LF	$ 1,898,600
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	$ -
Dewatering	$ 60.00	0	LF	$ -
Pavement Replacement (4 ft wide)	$ 40.00	10849	LF	$ 434,000
Shoring & Trench Safety	$ 22.00	10849	LF	$ 238,700
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	9	EA	$ 29,700
Excavation and Offhauling	$ 30.00	561	CY	$ 16,830
Mobilization & Demobilization	6%	1	LS	$ 156,100
Temporary Traffic Control	5%	1	LS	$ 130,100
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 52,000
Survey and Staking	1%	1	LS	$ 26,000
Total Unit Cost/LF	**$ 275**			
Total Pipeline Cost				**$ 2,982,030**

Sunnyvale (Guadalupe Slough) ROC Conveyance Pipeline Cost Estimate

Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
1.76 mgd ROC line - 12" 80 psi HDPE (Installed Cost)	$ 150.00	32760	LF	$ 4,914,000
Additional Cost for High Pressure Pipe	$ 0.70	113022	LB	$ 79,115
Dewatering	$ 60.00	32760	LF	$ 1,965,600
Pavement Replacement (4 ft wide)	$ 40.00	0	LF	$ -
Shoring & Trench Safety	$ 22.00	32760	LF	$ 720,700
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	25	EA	$ 82,500
Excavation and Offhauling	$ 30.00	1297	CY	$ 38,910
Mobilization & Demobilization	6%	1	LS	$ 465,700
Temporary Traffic Control		1	LS	
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 155,200
Survey and Staking	1%	1	LS	$ 77,600
Total Unit Cost/LF	**$ 259**			
Total Pipeline Cost				**$ 8,499,325**

Full Itemized Pump Station Cost Estimate Palo Alto

Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 50 HP, 2 duty/1 standby	$ 55,900
Motors	3x	$ 5,600
10" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material costs	$ 398,100
Civil Works	Concrete Pad, 12x12x1	$ 10,000

	Total Cost	$ 540,800

Full Itemized Pump Station Cost Estimate Sunnyvale

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 100 HP, 2 duty/1 standby	$ 97,800
Motors	3x	$ 11,300
10" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 100 HP VFDs	1x	$ 50,000
Mechanical Installation	3x material costs	$ 600,900
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	$ 811,200

Palo Alto (Existing Outfall) and Sunnyvale (Guadalupe Slough) ROC Management Cost Estimate

Item	Description	Total Cost
(2) Discharge Pipelines	14" and 12" HDPE Pipe	$ 11,481,355
PA ROC Pump Station	See Itemized List	$ 540,800
SV ROC Pump Station	See Itemized List	$ 811,200
Outfall Diffuser (SV)	In stream- multiport diffuser	$ 500,000
ROC Holding Tank (PA)	0.43 MG, 4 hrs holding time	$ 1,300,000
ROC Holding Tank (SV)	0.32 MG, 4 hrs holding time	$ 1,200,000
SUBTOTAL (CONSTRUCTION)		$ 15,833,355
Contingency	30%	$ 4,750,000
SUBTOTAL		$ 20,583,355
Tax on Materials	9%	$ 926,300
Overhead and Profit	12%	$ 2,470,000
Estimated Total Construction Costs		$ 23,979,655
Owner's Reserve for Change Orders	15%	$ 3,596,900
Engineering Services (Design)	15%	$ 3,596,900
Construction Management	13%	$ 3,117,400
Engineering Services During Construction	12%	$ 2,877,600
SUBTOTAL		$ 37,168,500
Treatment for CECs (Optional)		$ 2,120,000
Treatment for Nutrients (Optional)		$ 2,544,000
	Total Cost	$ 41,833,000

Sunnyvale (Guadalupe Slough) ROC Conveyance Pipeline Cost Estimate				
Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
1.76 mgd ROC line - 12" 80 psi HDPE (Installed Cost)	$ 150.00	32760	LF	$ 4,914,000
Additional Cost for High Pressure Pipe	$ 0.70	0	LB	$ -
Dewatering	$ 60.00	32760	LF	$ 1,965,600
Pavement Replacement (4 ft wide)	$ 40.00	0	LF	$ -
Shoring & Trench Safety	$ 22.00	32760	LF	$ 720,700
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	25	EA	$ 82,500
Excavation and Offhauling	$ 30.00	1297	CY	$ 38,910
Mobilization & Demobilization	6%	1	LS	$ 461,000
Temporary Traffic Control		1	LS	
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 153,700
Survey and Staking	1%	1	LS	$ 76,800
Total Unit Cost/LF	**$ 257**			
Total Pipeline Cost				**$ 8,413,200**

Palo Alto Deep Water Outfall (Land Portion) Cost Estimate				
Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
2.47 mgd ROC line - 14" 50 psi HDPE (Installed Cost)	$ 175.00	14563	LF	$ 2,548,500
Additional Cost for High Pressure Pipe	$ 0.70	113022	LB	$ 79,115
Dewatering	$ 60.00	1821	LF	$ 109,260
Pavement Replacement (4 ft wide)	$ 40.00	12742	LF	$ 509,700
Shoring & Trench Safety	$ 22.00	14563	LF	$ 320,400
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	12	EA	$ 39,600
Excavation and Offhauling	$ 30.00	753	CY	$ 22,590
Mobilization & Demobilization	6%	1	LS	$ 216,400
Temporary Traffic Control		1	LS	$ 157,200
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 72,100
Survey and Staking	1%	1	LS	$ 36,100
Total Unit Cost/LF	**$ 282**			
Total Pipeline Cost				**$ 4,111,000**

Palo Alto Deep Water Outfall (Marine Portion) Cost Estimate				
Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
Mobilization Horiz Directional Drill (HDD) Equip	$ 1,250,000	1	LS	$ 1,250,000
Staging Area on Levee (HDD Entry Pit)	$ 250,000	1	LS	$ 250,000
18" HDPE Outfall Pipe Installed thru Wetland (HDD)	$ 2,500	1,000	LF	$ 2,500,000
Exit Pit, Connect b/w HDD and Weighted Outfall	$ 500,000	1	LS	$ 500,000
Mobilization of Dredges and Barges (Marine Equip)	$ 2,000,000	0	LS	$ -
Marine Cut Trench (w/ Hyd. Dredge Equip to -20)	$ 2,000	0	LF	$ -
18" HDPE Outfall Installed w/ Concrete Weights	$ 2,500	0	LF	$ -
Diffuser at End of Outfall (includes piling)	$ 1,500,000	1	LS	$ 1,500,000
Bonds and Insurance	2%	1	LS	$ 120,000
Marine Survey / Navigation Control	1%	1	LS	$ 60,000

Total Unit Cost/LF	$ 6,180	
Total In Water Pipeline Cost		**$ 6,180,000**

Full Itemized Pump Station Cost Estimate Palo Alto		
Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 50 HP, 2 duty/1 standby	$ 55,900
Motors	3x	$ 5,600
10" Butterfly Valves	6x	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material cost	$ 398,100
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 540,800**

Full Itemized Pump Station Cost Estimate Sunnyvale		
Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 100 HP, 2 duty/1 standby	$ 97,800
Motors	3x	$ 11,300
10" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 100 HP VFDs	1x	$ 50,000
Mechanical Installation	3x material costs	$ 600,900
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 811,200**

Palo Alto (1000 LF Into Bay) and Sunnyvale (Guadalupe Slough) ROC Management Cost Estimate		
Item	**Description**	**Total Cost**
(2) Discharge Pipelines	14" and 12" HDPE Pipe	$ 18,704,200
PA ROC Pump Station	See Itemized List	$ 540,800
SV ROC Pump Station	See Itemized List	$ 811,200
Outfall Diffuser (SV)	In stream- multiport diffuser	$ 500,000
ROC Holding Tank (PA)	.43 MG, 4 hrs holding time	$ 1,300,000
ROC Holding Tank (SV)	.32 MG, 4 hrs holding time	$ 1,200,000
SUBTOTAL (CONSTRUCTION)		$ 23,056,200
Contingency	30%	$ 6,916,900
SUBTOTAL		$ 29,973,100
Tax on Materials	9%	$ 1,348,800
Overhead and Profit	12%	$ 3,596,800
Estimated Total Construction Costs		$ 34,918,700
Owner's Reserve for Change Orders	15%	$ 5,237,800
Engineering Services (Design)	15%	$ 5,237,800
Construction Management	13%	$ 4,539,400

Engineering Services During Construction	12%	$	4,190,200
SUBTOTAL		$	54,123,900
Treatment for CECs (Optional)		$	2,120,000
Treatment for Nutrients (Optional)		$	2,544,000
	Total Cost	**$**	**58,788,000**

Sunnyvale (Guadalupe Slough) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
1.76 mgd ROC line - 12" 80 psi HDPE (Installed Cost)	$ 150.00	32760	LF	$ 4,914,000
Additional Cost for High Pressure Pipe	$ 0.70	113022	LB	$ 79,115
Dewatering	$ 60.00	32760	LF	$ 1,965,600
Pavement Replacement (4 ft wide)	$ 40.00	0	LF	$ -
Shoring & Trench Safety	$ 22.00	32760	LF	$ 720,700
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	25	EA	$ 82,500
Excavation and Offhauling	$ 30.00	1297	CY	$ 38,910
Mobilization & Demobilization	6%	1	LS	$ 465,700
Temporary Traffic Control		1	LS	
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 155,200
Survey and Staking	1%	1	LS	$ 77,600
Total Unit Cost/LF	**$ 259**			
Total Pipeline Cost				**$ 8,499,300**

Palo Alto (SVCW) ROC Conveyance Pipeline Cost Estimate

Item	Unit Cost	Quantity	Unit	Total Cost
2.47 mgd ROC line - 14" 200 psi HDPE (Installed Cost)	$ 175.00	70257	LF	$ 12,295,000
Additional Cost for High Pressure Pipe	$ 0.70	2137921	LB	$ 1,496,544
Dewatering	$ 60.00	0	LF	$ -
Pavement Replacement (4 ft wide)	$ 40.00	70257	LF	$ 2,810,300
Shoring & Trench Safety	$ 22.00	70257	LF	$ 1,545,700
12" Butterfly Valve (every 0.25 miles)	$ 3,300.00	54	EA	$ 178,200
Excavation and Offhauling	$ 30.00	3633	CY	$ 108,990
Mobilization & Demobilization	6%	1	LS	$ 1,099,500
Temporary Traffic Control	5%	1	LS	$ 916,300
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 139,200
Survey and Staking	1%	1	LS	$ 69,600
Total Unit Cost/LF	**$ 294**			
Total Pipeline Cost				**$ 20,659,300**

Full Itemized Pump Station Cost Estimate Palo Alto

Item	Description	Total Cost
Pumps	2205 Duplex pumps, 200 HP, 2 duty/1 standby	$ 116,600
Motors	3x	$ 17,300
10" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000

MCC w/ (3) 200 HP VFDs	1x	$ 70,000
Mechanical Installation	3x material costs	$ 735,300
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 990,400**

Full Itemized Pump Station Cost Estimate Sunnyvale

Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 100 HP, 2 duty/1 standby	$ 97,800
Motors	3x	$ 11,300
10" Butterfly Valves	6x, 2205 Duplex, 3 actuators	$ 31,200
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 100 HP VFDs	1x	$ 50,000
Mechanical Installation	3x material costs	$ 600,900
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 811,200**

Palo Alto (SVCW) and Sunnyvale (Guadalupe Slough) Portfolio 4 ROC Management Cost Estimate

Item	**Description**	**Total Cost**
(2) Discharge Pipelines	14" and 12" HDPE Pipe	$ 29,158,600
PA ROC Pump Station	See Itemized List	$ 990,400
SV ROC Pump Station	See Itemized List	$ 811,200
Outfall Diffuser (SV)	In stream- multiport diffuser	$ 500,000
ROC Holding Tank (PA)	.43 MG, 4 hrs holding time	$ 1,300,000
ROC Holding Tank (SV)	.32 MG, 4 hrs holding time	$ 1,200,000
SUBTOTAL (CONSTRUCTION)		$ 33,960,200
Contingency	30%	$ 10,188,100
SUBTOTAL		$ 44,148,300
Tax on Materials	9%	$ 1,986,700
Overhead and Profit	12%	$ 5,297,800
Estimated Total Construction Costs		$ 51,432,800
Owner's Reserve for Change Orders	15%	$ 7,714,900
Engineering Services (Design)	15%	$ 7,714,900
Construction Management	13%	$ 6,686,300
Engineering Services During Construction	12%	$ 6,171,900
SUBTOTAL		$ 79,720,800
Treatment for CECs (Optional)		$ 2,120,000
Treatment for Nutrients (Optional)		$ 2,544,000
	Total Cost	**$ 84,385,000**

Morgan Hill ROC Conveyance Pipeline Cost Estimate				
Item	**Unit Cost**	**Quantity**	**Unit**	**Total Cost**
0.4 mgd ROC line - 8" 160 psi HDPE (Installed Cost)	$ 100.00	58600	LF	$ 5,860,000
Additional Cost for High Pressure Pipe	$ 0.70	314096	LB	$ 219,867
Dewatering	$ 60.00	0	LF	$ -
Pavement Replacement (4 ft wide)	$ 40.00	58600	LF	$ 2,344,000
Shoring & Trench Safety	$ 22.00	58600	LF	$ 1,289,200
8" Butterfly Valve (every 0.25 miles)	$ 2,350.00	45	EA	$ 105,750
Excavation and Offhauling	$ 30.00	1184	CY	$ 35,520
Mobilization & Demobilization	6%	1	LS	$ 589,100
Temporary Traffic Control	5%	1	LS	$ 490,941
Verify Field Dimensions & Utility Locations	2%	1	LS	$ 196,400
Survey and Staking	1%	1	LS	$ 98,200
Total Unit Cost/LF	**$ 192**			
Total Pipeline Cost				**$ 11,229,000**

Full Itemized Pump Station Cost Estimate Morgan Hill		
Item	**Description**	**Total Cost**
Pumps	2205 Duplex pumps, 50 HP, 2 duty/ 1 standby	$ 55,900
Motors		$ 5,600
5" Butterfly Isolation Valves	6x, 2205 Duplex, 3 actuators	$ 21,300
Pressure Indicators	2x	$ 4,000
Flow Indicator	1x	$ 6,000
MCC w/ (3) 50 HP VFDs	1x	$ 30,000
Mechanical Installation	3x material cost	$ 368,400
Civil Works	Concrete Pad, 12x12x1	$ 10,000
	Total Cost	**$ 501,200**

Morgan Hill ROC Management Cost Estimate			
Item	**Description**		**Total Cost**
Conveyance Pipeline	8", 50 psi HDPE Pipe		$ 11,229,000
ROC Pump Station	See Itemized List		$ 501,200
ROC Holding Tank	67,000 gal, 4 hrs holding time		$ 67,000
Excavation	$8/CY		$ 5,937,100
SUBTOTAL (CONSTRUCTION)			$ 17,734,300
Contingency		30%	$ 5,320,300
SUBTOTAL			$ 23,054,600
Tax on Materials		9%	$ 1,037,500
Overhead and Profit		12%	$ 2,766,600
Estimated Total Construction Costs			$ 26,858,700
Owner's Reserve for Change Orders		15%	$ 4,028,800

Engineering Services (Design)		15%	$ 4,028,800
Construction Management		13%	$ 3,491,600
Engineering Services During Construction		12%	$ 3,223,000
SUBTOTAL			$ 41,630,900
Cost of Land			$ 15,000,000
Double Liner System	Enviro Liner 6000x		$ 8,845,000
		Total Cost	**$ 50,476,000**

Appendix III: 30 and 100 Year Life Cycle Costs for ROC Management Options

Portfolio 1: Blending after the Effluent Weir

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 19,295,000	$ 181,701,775	$ 3,179,600	$ 204,176,375	$ 75,163,987	1,850,000	585,214
30-Yr Lifecycle		$ 19,295,000	$ 54,510,533	$ 791,810	$ 74,597,343	$ 49,739,629	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 4,823,750			$ 4,823,750	$ 4,382,038		
2025		$ 4,823,750			$ 4,823,750	$ 4,278,080		
2026		$ 4,823,750			$ 4,823,750	$ 4,176,589		
2027		$ 4,823,750			$ 4,823,750	$ 4,077,506		
2028	Year 1		$ 1,817,018		$ 1,817,018	$ 1,499,484	18,500	15,267
2029	Year 2		$ 1,817,018		$ 1,817,018	$ 1,463,911	18,500	14,905
2030	Year 3		$ 1,817,018		$ 1,817,018	$ 1,429,182	18,500	14,551
2031	Year 4		$ 1,817,018		$ 1,817,018	$ 1,395,276	18,500	14,206
2032	Year 5		$ 1,817,018		$ 1,817,018	$ 1,362,176	18,500	13,869
2033	Year 6		$ 1,817,018		$ 1,817,018	$ 1,329,860	18,500	13,540
2034	Year 7		$ 1,817,018		$ 1,817,018	$ 1,298,311	18,500	13,219
2035	Year 8		$ 1,817,018		$ 1,817,018	$ 1,267,511	18,500	12,905
2036	Year 9		$ 1,817,018		$ 1,817,018	$ 1,237,441	18,500	12,599
2037	Year 10		$ 1,817,018	$ 18,450	$ 1,835,468	$ 1,220,351	18,500	12,300
2038	Year 11		$ 1,817,018		$ 1,817,018	$ 1,179,424	18,500	12,008
2039	Year 12		$ 1,817,018		$ 1,817,018	$ 1,151,444	18,500	11,723
2040	Year 13		$ 1,817,018		$ 1,817,018	$ 1,124,128	18,500	11,445
2041	Year 14		$ 1,817,018		$ 1,817,018	$ 1,097,460	18,500	11,174
2042	Year 15		$ 1,817,018	$ 600	$ 1,817,618	$ 1,071,778	18,500	10,909
2043	Year 16		$ 1,817,018		$ 1,817,018	$ 1,046,006	18,500	10,650
2044	Year 17		$ 1,817,018		$ 1,817,018	$ 1,021,191	18,500	10,397
2045	Year 18		$ 1,817,018		$ 1,817,018	$ 996,965	18,500	10,151
2046	Year 19		$ 1,817,018		$ 1,817,018	$ 973,313	18,500	9,910
2047	Year 20		$ 1,817,018	$ 201,310	$ 2,018,328	$ 1,055,499	18,500	9,675
2048	Year 21		$ 1,817,018		$ 1,817,018	$ 927,680	18,500	9,445
2049	Year 22		$ 1,817,018	$ 30,000	$ 1,847,018	$ 920,626	18,500	9,221
2050	Year 23		$ 1,817,018		$ 1,817,018	$ 884,187	18,500	9,002
2051	Year 24		$ 1,817,018		$ 1,817,018	$ 863,211	18,500	8,789
2052	Year 25		$ 1,817,018	$ 390,000	$ 2,207,018	$ 1,023,614	18,500	8,580
2053	Year 26		$ 1,817,018		$ 1,817,018	$ 822,740	18,500	8,377
2054	Year 27		$ 1,817,018		$ 1,817,018	$ 803,221	18,500	8,178
2055	Year 28		$ 1,817,018		$ 1,817,018	$ 784,166	18,500	7,984
2056	Year 29		$ 1,817,018		$ 1,817,018	$ 765,563	18,500	7,795
2057	Year 30		$ 1,817,018	$ 151,450	$ 1,968,468	$ 809,698	18,500	7,610
2058	Year 31		$ 1,817,018		$ 1,817,018	$ 729,670	18,500	7,429
2059	Year 32		$ 1,817,018		$ 1,817,018	$ 712,360	18,500	7,253
2060	Year 33		$ 1,817,018		$ 1,817,018	$ 695,460	18,500	7,081
2061	Year 34		$ 1,817,018		$ 1,817,018	$ 678,961	18,500	6,913
2062	Year 35		$ 1,817,018		$ 1,817,018	$ 662,854	18,500	6,749
2063	Year 36		$ 1,817,018		$ 1,817,018	$ 647,129	18,500	6,589
2064	Year 37		$ 1,817,018		$ 1,817,018	$ 631,777	18,500	6,432
2065	Year 38		$ 1,817,018		$ 1,817,018	$ 616,789	18,500	6,280
2066	Year 39		$ 1,817,018		$ 1,817,018	$ 602,156	18,500	6,131
2067	Year 40		$ 1,817,018	$ 201,310	$ 2,018,328	$ 653,002	18,500	5,985
2068	Year 41		$ 1,817,018		$ 1,817,018	$ 573,925	18,500	5,843
2069	Year 42		$ 1,817,018		$ 1,817,018	$ 560,309	18,500	5,705
2070	Year 43		$ 1,817,018		$ 1,817,018	$ 547,017	18,500	5,569
2071	Year 44		$ 1,817,018	$ 30,000	$ 1,847,018	$ 542,857	18,500	5,437
2072	Year 45		$ 1,817,018	$ 600	$ 1,817,618	$ 521,542	18,500	5,308
2073	Year 46		$ 1,817,018		$ 1,817,018	$ 509,001	18,500	5,182
2074	Year 47		$ 1,817,018		$ 1,817,018	$ 496,926	18,500	5,059
2075	Year 48		$ 1,817,018		$ 1,817,018	$ 485,137	18,500	4,939
2076	Year 49		$ 1,817,018		$ 1,817,018	$ 473,628	18,500	4,822
2077	Year 50		$ 1,817,018	$ 408,450	$ 2,225,468	$ 566,334	18,500	4,708
2078	Year 51		$ 1,817,018		$ 1,817,018	$ 451,422	18,500	4,596
2079	Year 52		$ 1,817,018		$ 1,817,018	$ 440,713	18,500	4,487
2080	Year 53		$ 1,817,018		$ 1,817,018	$ 430,258	18,500	4,381
2081	Year 54		$ 1,817,018		$ 1,817,018	$ 420,051	18,500	4,277
2082	Year 55		$ 1,817,018		$ 1,817,018	$ 410,086	18,500	4,175
2083	Year 56		$ 1,817,018		$ 1,817,018	$ 400,357	18,500	4,076
2084	Year 57		$ 1,817,018		$ 1,817,018	$ 390,859	18,500	3,980
2085	Year 58		$ 1,817,018		$ 1,817,018	$ 381,586	18,500	3,885
2086	Year 59		$ 1,817,018		$ 1,817,018	$ 372,534	18,500	3,793
2087	Year 60		$ 1,817,018	$ 334,310	$ 2,151,328	$ 430,612	18,500	3,703
2088	Year 61		$ 1,817,018		$ 1,817,018	$ 355,068	18,500	3,615
2089	Year 62		$ 1,817,018		$ 1,817,018	$ 346,644	18,500	3,529
2090	Year 63		$ 1,817,018		$ 1,817,018	$ 338,421	18,500	3,446
2091	Year 64		$ 1,817,018		$ 1,817,018	$ 330,392	18,500	3,364
2092	Year 65		$ 1,817,018		$ 1,817,018	$ 322,554	18,500	3,284
2093	Year 66		$ 1,817,018	$ 30,000	$ 1,847,018	$ 320,101	18,500	3,206
2094	Year 67		$ 1,817,018		$ 1,817,018	$ 307,432	18,500	3,130
2095	Year 68		$ 1,817,018		$ 1,817,018	$ 300,138	18,500	3,056
2096	Year 69		$ 1,817,018		$ 1,817,018	$ 293,018	18,500	2,983
2097	Year 70		$ 1,817,018	$ 18,450	$ 1,835,468	$ 288,971	18,500	2,913
2098	Year 71		$ 1,817,018		$ 1,817,018	$ 279,280	18,500	2,843
2099	Year 72		$ 1,817,018		$ 1,817,018	$ 272,654	18,500	2,776
2100	Year 73		$ 1,817,018		$ 1,817,018	$ 266,186	18,500	2,710
2101	Year 74		$ 1,817,018		$ 1,817,018	$ 259,871	18,500	2,646
2102	Year 75		$ 1,817,018	$ 390,600	$ 2,207,618	$ 308,245	18,500	2,583
2103	Year 76		$ 1,817,018		$ 1,817,018	$ 247,687	18,500	2,522
2104	Year 77		$ 1,817,018		$ 1,817,018	$ 241,811	18,500	2,462
2105	Year 78		$ 1,817,018		$ 1,817,018	$ 236,075	18,500	2,404
2106	Year 79		$ 1,817,018		$ 1,817,018	$ 230,474	18,500	2,347
2107	Year 80		$ 1,817,018	$ 201,310	$ 2,018,328	$ 249,935	18,500	2,291
2108	Year 81		$ 1,817,018		$ 1,817,018	$ 219,669	18,500	2,237
2109	Year 82		$ 1,817,018		$ 1,817,018	$ 214,457	18,500	2,184
2110	Year 83		$ 1,817,018		$ 1,817,018	$ 209,370	18,500	2,132
2111	Year 84		$ 1,817,018		$ 1,817,018	$ 204,403	18,500	2,081
2112	Year 85		$ 1,817,018		$ 1,817,018	$ 199,553	18,500	2,032
2113	Year 86		$ 1,817,018		$ 1,817,018	$ 194,819	18,500	1,984
2114	Year 87		$ 1,817,018		$ 1,817,018	$ 190,198	18,500	1,936
2115	Year 88		$ 1,817,018	$ 30,000	$ 1,847,018	$ 188,751	18,500	1,891
2116	Year 89		$ 1,817,018		$ 1,817,018	$ 181,280	18,500	1,846
2117	Year 90		$ 1,817,018	$ 151,450	$ 1,968,468	$ 191,731	18,500	1,802
2118	Year 91		$ 1,817,018		$ 1,817,018	$ 172,781	18,500	1,759
2119	Year 92		$ 1,817,018		$ 1,817,018	$ 168,682	18,500	1,717
2120	Year 93		$ 1,817,018		$ 1,817,018	$ 164,680	18,500	1,677
2121	Year 94		$ 1,817,018		$ 1,817,018	$ 160,774	18,500	1,637
2122	Year 95		$ 1,817,018		$ 1,817,018	$ 156,959	18,500	1,598
2123	Year 96		$ 1,817,018		$ 1,817,018	$ 153,236	18,500	1,560
2124	Year 97		$ 1,817,018		$ 1,817,018	$ 149,601	18,500	1,523
2125	Year 98		$ 1,817,018		$ 1,817,018	$ 146,052	18,500	1,487
2126	Year 99		$ 1,817,018		$ 1,817,018	$ 142,587	18,500	1,452
2127	Year 100		$ 1,817,018	$ 591,310	$ 2,408,328	$ 184,505	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
151	128

Portfolio 1: Blending after the Effluent Weir

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	9,536
Operator Salary/hr	$ 163.20
Yearly Cost	$ 15,562.75

Electricity Costs	
2025	20,218
2035	20,218

Treatment Costs	
2025	1,781,037
2035	1,781,037

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	1,550,000	100	25	25%					$ 387,500	
Epoxy Coating	-	20	10	30%						
Conveyance Pipeline (HDPE)	2,384,000	100	20	4%			$ 95,360			
Valves	132,400	30	-	-						$ 132,400
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation (not including flow meters)	4,000	15	-	-		$ 600				
Pumps (Process/Product)	55,900	20	10	30%	$ 16,770		$ 55,900			
Motors	5,600	20	10	30%	$ 1,680		$ 5,600			
Flow Meters	6,000	20	-	-			$ 6,000			
Diffuser	500,000	100	20	4%			$ 20,000			
Above grade concrete	10,000	100	25	25%					$ 2,500	
MCC	30,000	22	-	-				$ 30,000		
Evaporation Pond Liner	-	10	-	-						
				Totals	$ 18,450	$ 600	$ 182,860	$ 30,000	$ 390,000	$ 132,400

Portfolio 1: Extension to Coyote Creek

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 29,031,000	$ 184,022,015	$ 4,369,300	$ 217,422,315	$ 84,732,903	1,850,000	585,214
30-Yr Lifecycle		$ 29,031,000	$ 55,206,605	$ 1,075,550	$ 85,313,155	$ 58,829,324	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 7,257,750			$ 7,257,750	$ 6,593,155		
2025		$ 7,257,750			$ 7,257,750	$ 6,436,743		
2026		$ 7,257,750			$ 7,257,750	$ 6,284,040		
2027		$ 7,257,750			$ 7,257,750	$ 6,134,961		
2028	Year 1		$ 1,840,220		$ 1,840,220	$ 1,518,631	18,500	15,267
2029	Year 2		$ 1,840,220		$ 1,840,220	$ 1,482,604	18,500	14,905
2030	Year 3		$ 1,840,220		$ 1,840,220	$ 1,447,432	18,500	14,551
2031	Year 4		$ 1,840,220		$ 1,840,220	$ 1,413,093	18,500	14,206
2032	Year 5		$ 1,840,220		$ 1,840,220	$ 1,379,570	18,500	13,869
2033	Year 6		$ 1,840,220		$ 1,840,220	$ 1,346,842	18,500	13,540
2034	Year 7		$ 1,840,220		$ 1,840,220	$ 1,314,890	18,500	13,219
2035	Year 8		$ 1,840,220		$ 1,840,220	$ 1,283,696	18,500	12,905
2036	Year 9		$ 1,840,220		$ 1,840,220	$ 1,253,242	18,500	12,599
2037	Year 10		$ 1,840,220	$ 32,730	$ 1,872,950	$ 1,245,272	18,500	12,300
2038	Year 11		$ 1,840,220		$ 1,840,220	$ 1,194,485	18,500	12,008
2039	Year 12		$ 1,840,220		$ 1,840,220	$ 1,166,148	18,500	11,723
2040	Year 13		$ 1,840,220		$ 1,840,220	$ 1,138,482	18,500	11,445
2041	Year 14		$ 1,840,220		$ 1,840,220	$ 1,111,474	18,500	11,174
2042	Year 15		$ 1,840,220	$ 600	$ 1,840,820	$ 1,085,459	18,500	10,909
2043	Year 16		$ 1,840,220		$ 1,840,220	$ 1,059,363	18,500	10,650
2044	Year 17		$ 1,840,220		$ 1,840,220	$ 1,034,231	18,500	10,397
2045	Year 18		$ 1,840,220		$ 1,840,220	$ 1,009,696	18,500	10,151
2046	Year 19		$ 1,840,220		$ 1,840,220	$ 985,742	18,500	9,910
2047	Year 20		$ 1,840,220	$ 367,690	$ 2,207,910	$ 1,154,643	18,500	9,675
2048	Year 21		$ 1,840,220		$ 1,840,220	$ 939,526	18,500	9,445
2049	Year 22		$ 1,840,220	$ 50,000	$ 1,890,220	$ 942,159	18,500	9,221
2050	Year 23		$ 1,840,220		$ 1,840,220	$ 895,477	18,500	9,002
2051	Year 24		$ 1,840,220		$ 1,840,220	$ 874,233	18,500	8,789
2052	Year 25		$ 1,840,220	$ 390,000	$ 2,230,220	$ 1,034,375	18,500	8,580
2053	Year 26		$ 1,840,220		$ 1,840,220	$ 833,246	18,500	8,377
2054	Year 27		$ 1,840,220		$ 1,840,220	$ 813,478	18,500	8,178
2055	Year 28		$ 1,840,220		$ 1,840,220	$ 794,180	18,500	7,984
2056	Year 29		$ 1,840,220		$ 1,840,220	$ 775,339	18,500	7,795
2057	Year 30		$ 1,840,220	$ 234,530	$ 2,074,750	$ 853,415	18,500	7,610
2058	Year 31		$ 1,840,220		$ 1,840,220	$ 738,988	18,500	7,429
2059	Year 32		$ 1,840,220		$ 1,840,220	$ 721,456	18,500	7,253
2060	Year 33		$ 1,840,220		$ 1,840,220	$ 704,341	18,500	7,081
2061	Year 34		$ 1,840,220		$ 1,840,220	$ 687,631	18,500	6,913
2062	Year 35		$ 1,840,220		$ 1,840,220	$ 671,318	18,500	6,749
2063	Year 36		$ 1,840,220		$ 1,840,220	$ 655,392	18,500	6,589
2064	Year 37		$ 1,840,220		$ 1,840,220	$ 639,844	18,500	6,432
2065	Year 38		$ 1,840,220		$ 1,840,220	$ 624,665	18,500	6,280
2066	Year 39		$ 1,840,220		$ 1,840,220	$ 609,846	18,500	6,131
2067	Year 40		$ 1,840,220	$ 367,690	$ 2,207,910	$ 714,339	18,500	5,985
2068	Year 41		$ 1,840,220		$ 1,840,220	$ 581,253	18,500	5,843
2069	Year 42		$ 1,840,220		$ 1,840,220	$ 567,464	18,500	5,705
2070	Year 43		$ 1,840,220		$ 1,840,220	$ 554,002	18,500	5,569
2071	Year 44		$ 1,840,220	$ 50,000	$ 1,890,220	$ 555,554	18,500	5,437
2072	Year 45		$ 1,840,220	$ 600	$ 1,840,820	$ 528,200	18,500	5,308
2073	Year 46		$ 1,840,220		$ 1,840,220	$ 515,501	18,500	5,182
2074	Year 47		$ 1,840,220		$ 1,840,220	$ 503,272	18,500	5,059
2075	Year 48		$ 1,840,220		$ 1,840,220	$ 491,332	18,500	4,939
2076	Year 49		$ 1,840,220		$ 1,840,220	$ 479,676	18,500	4,822
2077	Year 50		$ 1,840,220	$ 422,730	$ 2,262,950	$ 575,872	18,500	4,708
2078	Year 51		$ 1,840,220		$ 1,840,220	$ 457,187	18,500	4,596
2079	Year 52		$ 1,840,220		$ 1,840,220	$ 446,341	18,500	4,487
2080	Year 53		$ 1,840,220		$ 1,840,220	$ 435,752	18,500	4,381
2081	Year 54		$ 1,840,220		$ 1,840,220	$ 425,414	18,500	4,277
2082	Year 55		$ 1,840,220		$ 1,840,220	$ 415,322	18,500	4,175
2083	Year 56		$ 1,840,220		$ 1,840,220	$ 405,469	18,500	4,076
2084	Year 57		$ 1,840,220		$ 1,840,220	$ 395,850	18,500	3,980
2085	Year 58		$ 1,840,220		$ 1,840,220	$ 386,459	18,500	3,885
2086	Year 59		$ 1,840,220		$ 1,840,220	$ 377,291	18,500	3,793
2087	Year 60		$ 1,840,220	$ 569,490	$ 2,409,710	$ 482,330	18,500	3,703
2088	Year 61		$ 1,840,220		$ 1,840,220	$ 359,602	18,500	3,615
2089	Year 62		$ 1,840,220		$ 1,840,220	$ 351,071	18,500	3,529
2090	Year 63		$ 1,840,220		$ 1,840,220	$ 342,742	18,500	3,446
2091	Year 64		$ 1,840,220		$ 1,840,220	$ 334,611	18,500	3,364
2092	Year 65		$ 1,840,220		$ 1,840,220	$ 326,673	18,500	3,284
2093	Year 66		$ 1,840,220	$ 50,000	$ 1,890,220	$ 327,589	18,500	3,206
2094	Year 67		$ 1,840,220		$ 1,840,220	$ 311,357	18,500	3,130
2095	Year 68		$ 1,840,220		$ 1,840,220	$ 303,971	18,500	3,056
2096	Year 69		$ 1,840,220		$ 1,840,220	$ 296,760	18,500	2,983
2097	Year 70		$ 1,840,220	$ 32,730	$ 1,872,950	$ 294,872	18,500	2,913
2098	Year 71		$ 1,840,220		$ 1,840,220	$ 282,846	18,500	2,843
2099	Year 72		$ 1,840,220		$ 1,840,220	$ 276,136	18,500	2,776
2100	Year 73		$ 1,840,220		$ 1,840,220	$ 269,585	18,500	2,710
2101	Year 74		$ 1,840,220		$ 1,840,220	$ 263,190	18,500	2,646
2102	Year 75		$ 1,840,220	$ 390,600	$ 2,230,820	$ 311,484	18,500	2,583
2103	Year 76		$ 1,840,220		$ 1,840,220	$ 250,850	18,500	2,522
2104	Year 77		$ 1,840,220		$ 1,840,220	$ 244,899	18,500	2,462
2105	Year 78		$ 1,840,220		$ 1,840,220	$ 239,089	18,500	2,404
2106	Year 79		$ 1,840,220		$ 1,840,220	$ 233,417	18,500	2,347
2107	Year 80		$ 1,840,220	$ 367,690	$ 2,207,910	$ 273,412	18,500	2,291
2108	Year 81		$ 1,840,220		$ 1,840,220	$ 222,474	18,500	2,237
2109	Year 82		$ 1,840,220		$ 1,840,220	$ 217,196	18,500	2,184
2110	Year 83		$ 1,840,220		$ 1,840,220	$ 212,043	18,500	2,132
2111	Year 84		$ 1,840,220		$ 1,840,220	$ 207,013	18,500	2,081
2112	Year 85		$ 1,840,220		$ 1,840,220	$ 202,102	18,500	2,032
2113	Year 86		$ 1,840,220		$ 1,840,220	$ 197,307	18,500	1,984
2114	Year 87		$ 1,840,220		$ 1,840,220	$ 192,626	18,500	1,936
2115	Year 88		$ 1,840,220	$ 50,000	$ 1,890,220	$ 193,166	18,500	1,891
2116	Year 89		$ 1,840,220		$ 1,840,220	$ 183,595	18,500	1,846
2117	Year 90		$ 1,840,220	$ 234,530	$ 2,074,750	$ 202,083	18,500	1,802
2118	Year 91		$ 1,840,220		$ 1,840,220	$ 174,987	18,500	1,759
2119	Year 92		$ 1,840,220		$ 1,840,220	$ 170,836	18,500	1,717
2120	Year 93		$ 1,840,220		$ 1,840,220	$ 166,783	18,500	1,677
2121	Year 94		$ 1,840,220		$ 1,840,220	$ 162,827	18,500	1,637
2122	Year 95		$ 1,840,220		$ 1,840,220	$ 158,964	18,500	1,598
2123	Year 96		$ 1,840,220		$ 1,840,220	$ 155,193	18,500	1,560
2124	Year 97		$ 1,840,220		$ 1,840,220	$ 151,511	18,500	1,523
2125	Year 98		$ 1,840,220		$ 1,840,220	$ 147,917	18,500	1,487
2126	Year 99		$ 1,840,220		$ 1,840,220	$ 144,407	18,500	1,452
2127	Year 100		$ 1,840,220	$ 757,690	$ 2,597,910	$ 199,029	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
178	145

Portfolio 1: Extension to Coyote Creek

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	19,986
Operator Salary/hr	$ 163.20
Yearly Cost	$ 32,617.15

Electricity Costs	
2025	26,366
2035	26,366

Treatment Costs	
2025	1,781,037
2035	1,781,037

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	$ 1,550,000	100	25	25%					$ 387,500	
Epoxy Coating	-	20	10	30%						
Conveyance Pipeline (HDPE)	$ 4,996,500	100	20	4%			$ 199,860			
Valves	$ 201,200	30	-	-						$ 201,200
Electrical Equipment & Acc	-	25	-	-					-	
Instrumentation	$ 4,000	15	-	-		$ 600				
Pumps (Process/Product)	$ 97,800	20	10	30%	$ 29,340		$ 97,800			
Motors	$ 11,300	20	10	30%	$ 3,390		$ 11,300			
Flow Meters	$ 6,000	20	-	-			$ 6,000			
Diffuser	$ 500,000	100	20	4%			$ 20,000			
Above grade concrete	$ 10,000	100	25	25%					$ 2,500	
MCC	$ 50,000	22	-	-				$ 50,000		
Evaporation Pond Liner	-	10	-	-						
				Totals	$ 32,730	$ 600	$ 334,960	$ 50,000	$ 390,000	$ 201,200

Portfolio 2A: Blending with Palo Alto Effluent

Year	Operations Year #	Estimated Costs (January 2020 Dollars) Capital Costs	 O&M Cost	 R&R	 Total Cost	2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
100-Yr Lifecycle		$ 18,174,000	$ 134,247,057	$ 3,019,600	$ 177,808,180	$ 65,444,724	1,850,000	585,214
30-Yr Lifecycle		$ 18,174,000	$ 40,274,117	$ 750,290	$ 64,730,160	$ 43,264,034	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 4,543,500			$ 4,543,500	$ 4,127,450		
2025		$ 4,543,500			$ 4,543,500	$ 4,029,533		
2026		$ 4,543,500			$ 4,543,500	$ 3,933,938		
2027		$ 4,543,500			$ 4,543,500	$ 3,840,611		
2028	Year 1		$ 1,342,471		$ 1,342,471	$ 1,107,866	18,500	15,267
2029	Year 2		$ 1,342,471		$ 1,342,471	$ 1,081,584	18,500	14,905
2030	Year 3		$ 1,342,471		$ 1,342,471	$ 1,055,925	18,500	14,551
2031	Year 4		$ 1,342,471		$ 1,342,471	$ 1,030,875	18,500	14,206
2032	Year 5		$ 1,342,471		$ 1,342,471	$ 1,006,419	18,500	13,869
2033	Year 6		$ 1,342,471		$ 1,342,471	$ 982,543	18,500	13,540
2034	Year 7		$ 1,342,471		$ 1,342,471	$ 959,234	18,500	13,219
2035	Year 8		$ 1,582,982		$ 1,582,982	$ 1,104,252	18,500	12,905
2036	Year 9		$ 1,582,982		$ 1,582,982	$ 1,078,055	18,500	12,599
2037	Year 10		$ 1,582,982	$ 18,450	$ 1,601,432	$ 1,064,747	18,500	12,300
2038	Year 11		$ 1,582,982		$ 1,582,982	$ 1,027,512	18,500	12,008
2039	Year 12		$ 1,582,982		$ 1,582,982	$ 1,003,135	18,500	11,723
2040	Year 13		$ 1,582,982		$ 1,582,982	$ 979,338	18,500	11,445
2041	Year 14		$ 1,582,982		$ 1,582,982	$ 956,104	18,500	11,174
2042	Year 15		$ 1,582,982	$ 600	$ 1,583,582	$ 933,776	18,500	10,909
2043	Year 16		$ 1,582,982		$ 1,582,982	$ 911,278	18,500	10,650
2044	Year 17		$ 1,582,982		$ 1,582,982	$ 889,659	18,500	10,397
2045	Year 18		$ 1,582,982		$ 1,582,982	$ 868,553	18,500	10,151
2046	Year 19		$ 1,582,982		$ 1,582,982	$ 847,948	18,500	9,910
2047	Year 20		$ 1,582,982	$ 183,590	$ 1,766,572	$ 923,842	18,500	9,675
2048	Year 21		$ 1,582,982		$ 1,582,982	$ 808,193	18,500	9,445
2049	Year 22		$ 1,582,982	$ 30,000	$ 1,612,982	$ 803,973	18,500	9,221
2050	Year 23		$ 1,582,982		$ 1,582,982	$ 770,301	18,500	9,002
2051	Year 24		$ 1,582,982		$ 1,582,982	$ 752,027	18,500	8,789
2052	Year 25		$ 1,582,982	$ 390,000	$ 1,972,982	$ 915,068	18,500	8,580
2053	Year 26		$ 1,582,982		$ 1,582,982	$ 716,769	18,500	8,377
2054	Year 27		$ 1,582,982		$ 1,582,982	$ 699,765	18,500	8,178
2055	Year 28		$ 1,582,982		$ 1,582,982	$ 683,164	18,500	7,984
2056	Year 29		$ 1,582,982		$ 1,582,982	$ 666,957	18,500	7,795
2057	Year 30		$ 1,582,982	$ 127,650	$ 1,710,632	$ 703,641	18,500	7,610
2058	Year 31		$ 1,582,982		$ 1,582,982	$ 635,687	18,500	7,429
2059	Year 32		$ 1,582,982		$ 1,582,982	$ 620,606	18,500	7,253
2060	Year 33		$ 1,582,982		$ 1,582,982	$ 605,883	18,500	7,081
2061	Year 34		$ 1,582,982		$ 1,582,982	$ 591,510	18,500	6,913
2062	Year 35		$ 1,582,982		$ 1,582,982	$ 577,477	18,500	6,749
2063	Year 36		$ 1,582,982		$ 1,582,982	$ 563,777	18,500	6,589
2064	Year 37		$ 1,582,982		$ 1,582,982	$ 550,402	18,500	6,432
2065	Year 38		$ 1,582,982		$ 1,582,982	$ 537,345	18,500	6,280
2066	Year 39		$ 1,582,982		$ 1,582,982	$ 524,597	18,500	6,131
2067	Year 40		$ 1,582,982	$ 183,590	$ 1,766,572	$ 571,550	18,500	5,985
2068	Year 41		$ 1,582,982		$ 1,582,982	$ 500,002	18,500	5,843
2069	Year 42		$ 1,582,982		$ 1,582,982	$ 488,140	18,500	5,705
2070	Year 43		$ 1,582,982		$ 1,582,982	$ 476,560	18,500	5,569
2071	Year 44		$ 1,582,982	$ 30,000	$ 1,612,982	$ 474,071	18,500	5,437
2072	Year 45		$ 1,582,982	$ 600	$ 1,583,582	$ 454,389	18,500	5,308
2073	Year 46		$ 1,582,982		$ 1,582,982	$ 443,441	18,500	5,182
2074	Year 47		$ 1,582,982		$ 1,582,982	$ 432,921	18,500	5,059
2075	Year 48		$ 1,582,982		$ 1,582,982	$ 422,650	18,500	4,939
2076	Year 49		$ 1,582,982		$ 1,582,982	$ 412,624	18,500	4,822
2077	Year 50		$ 1,582,982	$ 408,450	$ 1,991,432	$ 506,777	18,500	4,708
2078	Year 51		$ 1,582,982		$ 1,582,982	$ 393,278	18,500	4,596
2079	Year 52		$ 1,582,982		$ 1,582,982	$ 383,948	18,500	4,487
2080	Year 53		$ 1,582,982		$ 1,582,982	$ 374,840	18,500	4,381
2081	Year 54		$ 1,582,982		$ 1,582,982	$ 365,947	18,500	4,277
2082	Year 55		$ 1,582,982		$ 1,582,982	$ 357,266	18,500	4,175
2083	Year 56		$ 1,582,982		$ 1,582,982	$ 348,790	18,500	4,076
2084	Year 57		$ 1,582,982		$ 1,582,982	$ 340,515	18,500	3,980
2085	Year 58		$ 1,582,982		$ 1,582,982	$ 332,437	18,500	3,885
2086	Year 59		$ 1,582,982		$ 1,582,982	$ 324,551	18,500	3,793
2087	Year 60		$ 1,582,982	$ 292,790	$ 1,875,772	$ 375,456	18,500	3,703
2088	Year 61		$ 1,582,982		$ 1,582,982	$ 309,334	18,500	3,615
2089	Year 62		$ 1,582,982		$ 1,582,982	$ 301,996	18,500	3,529
2090	Year 63		$ 1,582,982		$ 1,582,982	$ 294,831	18,500	3,446
2091	Year 64		$ 1,582,982		$ 1,582,982	$ 287,837	18,500	3,364
2092	Year 65		$ 1,582,982		$ 1,582,982	$ 281,008	18,500	3,284
2093	Year 66		$ 1,582,982	$ 30,000	$ 1,612,982	$ 279,541	18,500	3,206
2094	Year 67		$ 1,582,982		$ 1,582,982	$ 267,834	18,500	3,130
2095	Year 68		$ 1,582,982		$ 1,582,982	$ 261,480	18,500	3,056
2096	Year 69		$ 1,582,982		$ 1,582,982	$ 255,276	18,500	2,983
2097	Year 70		$ 1,582,982	$ 18,450	$ 1,601,432	$ 252,125	18,500	2,913
2098	Year 71		$ 1,582,982		$ 1,582,982	$ 243,308	18,500	2,843
2099	Year 72		$ 1,582,982		$ 1,582,982	$ 237,536	18,500	2,776
2100	Year 73		$ 1,582,982		$ 1,582,982	$ 231,901	18,500	2,710
2101	Year 74		$ 1,582,982		$ 1,582,982	$ 226,399	18,500	2,646
2102	Year 75		$ 1,582,982	$ 390,600	$ 1,973,582	$ 275,567	18,500	2,583
2103	Year 76		$ 1,582,982		$ 1,582,982	$ 215,785	18,500	2,522
2104	Year 77		$ 1,582,982		$ 1,582,982	$ 210,665	18,500	2,462
2105	Year 78		$ 1,582,982		$ 1,582,982	$ 205,668	18,500	2,404
2106	Year 79		$ 1,582,982		$ 1,582,982	$ 200,789	18,500	2,347
2107	Year 80		$ 1,582,982	$ 183,590	$ 1,766,572	$ 218,760	18,500	2,291
2108	Year 81		$ 1,582,982		$ 1,582,982	$ 191,375	18,500	2,237
2109	Year 82		$ 1,582,982		$ 1,582,982	$ 186,835	18,500	2,184
2110	Year 83		$ 1,582,982		$ 1,582,982	$ 182,402	18,500	2,132
2111	Year 84		$ 1,582,982		$ 1,582,982	$ 178,075	18,500	2,081
2112	Year 85		$ 1,582,982		$ 1,582,982	$ 173,851	18,500	2,032
2113	Year 86		$ 1,582,982		$ 1,582,982	$ 169,726	18,500	1,984
2114	Year 87		$ 1,582,982		$ 1,582,982	$ 165,700	18,500	1,936
2115	Year 88		$ 1,582,982	$ 30,000	$ 1,612,982	$ 164,834	18,500	1,891
2116	Year 89		$ 1,582,982		$ 1,582,982	$ 157,931	18,500	1,846
2117	Year 90		$ 1,582,982	$ 127,650	$ 1,710,632	$ 166,618	18,500	1,802
2118	Year 91		$ 1,582,982		$ 1,582,982	$ 150,526	18,500	1,759
2119	Year 92		$ 1,582,982		$ 1,582,982	$ 146,955	18,500	1,717
2120	Year 93		$ 1,582,982		$ 1,582,982	$ 143,469	18,500	1,677
2121	Year 94		$ 1,582,982		$ 1,582,982	$ 140,066	18,500	1,637
2122	Year 95		$ 1,582,982		$ 1,582,982	$ 136,743	18,500	1,598
2123	Year 96		$ 1,582,982		$ 1,582,982	$ 133,499	18,500	1,560
2124	Year 97		$ 1,582,982		$ 1,582,982	$ 130,332	18,500	1,523
2125	Year 98		$ 1,582,982		$ 1,582,982	$ 127,240	18,500	1,487
2126	Year 99		$ 1,582,982		$ 1,582,982	$ 124,221	18,500	1,452
2127	Year 100		$ 1,582,982	$ 573,590	$ 2,156,572	$ 165,218	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
131	112

Portfolio 2A: Blending with Palo Alto Effluent

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	10,849
Operator Salary/hr	$ 163.20
Yearly Cost	$ 17,705.57

Electricity Costs	
2025	19,899
2035	27,335

Treatment Costs	
2025	1,304,666
2035	1,537,741

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	1,550,000	100	25	25%					$ 387,500	
Epoxy Coating	-	20	10	30%						
Conveyance Pipeline (HDPE)	2441000	100	20	4%			$ 97,640			
Valves	108600	30	-	-						$ 108,600
Electrical Equipment & Acc	-	25	-	-					-	
Instrumentation	4000	15	-	-		$ 600				
Pumps (Process/Product)	55900	20	10	30%	$ 16,770		$ 55,900			
Motors	5600	20	10	30%	$ 1,680		$ 5,600			
Flow Meters	6000	20	-	-			$ 6,000			
Diffuser		100	20	4%			$ -			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	30,000	22	-	-				$ 30,000		
Evaporation Pond Liner	-	10	-	-						
				Totals	$ 18,450	$ 600	$ 165,140	$ 30,000	$ 390,000	$ 108,600

Portfolio 2A: Extension into San Francisco Bay

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 35,658,000	$ 135,416,082	$ 4,064,140	$ 197,728,945	$ 81,463,712	1,850,000	585,214
30-Yr Lifecycle		$ 35,658,000	$ 40,624,824	$ 969,518	$ 82,839,295	$ 58,941,188	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 8,914,500			$ 8,914,500	$ 8,098,196		
2025		$ 8,914,500			$ 8,914,500	$ 7,906,079		
2026		$ 8,914,500			$ 8,914,500	$ 7,718,519		
2027		$ 8,914,500			$ 8,914,500	$ 7,535,408		
2028	Year 1		$ 1,354,161		$ 1,354,161	$ 1,117,514	18,500	15,267
2029	Year 2		$ 1,354,161		$ 1,354,161	$ 1,091,002	18,500	14,905
2030	Year 3		$ 1,354,161		$ 1,354,161	$ 1,065,120	18,500	14,551
2031	Year 4		$ 1,354,161		$ 1,354,161	$ 1,039,852	18,500	14,206
2032	Year 5		$ 1,354,161		$ 1,354,161	$ 1,015,183	18,500	13,869
2033	Year 6		$ 1,354,161		$ 1,354,161	$ 991,099	18,500	13,540
2034	Year 7		$ 1,354,161		$ 1,354,161	$ 967,587	18,500	13,219
2035	Year 8		$ 1,597,072		$ 1,597,072	$ 1,114,081	18,500	12,905
2036	Year 9		$ 1,597,072		$ 1,597,072	$ 1,087,651	18,500	12,599
2037	Year 10		$ 1,597,072	$ 18,450	$ 1,615,522	$ 1,074,115	18,500	12,300
2038	Year 11		$ 1,597,072		$ 1,597,072	$ 1,036,658	18,500	12,008
2039	Year 12		$ 1,597,072		$ 1,597,072	$ 1,012,064	18,500	11,723
2040	Year 13		$ 1,597,072		$ 1,597,072	$ 988,055	18,500	11,445
2041	Year 14		$ 1,597,072		$ 1,597,072	$ 964,615	18,500	11,174
2042	Year 15		$ 1,597,072	$ 600	$ 1,597,672	$ 942,084	18,500	10,909
2043	Year 16		$ 1,597,072		$ 1,597,072	$ 919,389	18,500	10,650
2044	Year 17		$ 1,597,072		$ 1,597,072	$ 897,578	18,500	10,397
2045	Year 18		$ 1,597,072		$ 1,597,072	$ 876,284	18,500	10,151
2046	Year 19		$ 1,597,072		$ 1,597,072	$ 855,496	18,500	9,910
2047	Year 20		$ 1,597,072	$ 377,018	$ 1,974,090	$ 1,032,365	18,500	9,675
2048	Year 21		$ 1,597,072		$ 1,597,072	$ 815,387	18,500	9,445
2049	Year 22		$ 1,597,072	$ 30,000	$ 1,627,072	$ 810,996	18,500	9,221
2050	Year 23		$ 1,597,072		$ 1,597,072	$ 777,158	18,500	9,002
2051	Year 24		$ 1,597,072		$ 1,597,072	$ 758,721	18,500	8,789
2052	Year 25		$ 1,597,072	$ 390,000	$ 1,987,072	$ 921,603	18,500	8,580
2053	Year 26		$ 1,597,072		$ 1,597,072	$ 723,149	18,500	8,377
2054	Year 27		$ 1,597,072		$ 1,597,072	$ 705,993	18,500	8,178
2055	Year 28		$ 1,597,072		$ 1,597,072	$ 689,245	18,500	7,984
2056	Year 29		$ 1,597,072		$ 1,597,072	$ 672,893	18,500	7,795
2057	Year 30		$ 1,597,072	$ 153,450	$ 1,750,522	$ 720,049	18,500	7,610
2058	Year 31		$ 1,597,072		$ 1,597,072	$ 641,345	18,500	7,429
2059	Year 32		$ 1,597,072		$ 1,597,072	$ 626,130	18,500	7,253
2060	Year 33		$ 1,597,072		$ 1,597,072	$ 611,276	18,500	7,081
2061	Year 34		$ 1,597,072		$ 1,597,072	$ 596,775	18,500	6,913
2062	Year 35		$ 1,597,072		$ 1,597,072	$ 582,617	18,500	6,749
2063	Year 36		$ 1,597,072		$ 1,597,072	$ 568,795	18,500	6,589
2064	Year 37		$ 1,597,072		$ 1,597,072	$ 555,301	18,500	6,432
2065	Year 38		$ 1,597,072		$ 1,597,072	$ 542,128	18,500	6,280
2066	Year 39		$ 1,597,072		$ 1,597,072	$ 529,267	18,500	6,131
2067	Year 40		$ 1,597,072	$ 377,018	$ 1,974,090	$ 638,690	18,500	5,985
2068	Year 41		$ 1,597,072		$ 1,597,072	$ 504,452	18,500	5,843
2069	Year 42		$ 1,597,072		$ 1,597,072	$ 492,485	18,500	5,705
2070	Year 43		$ 1,597,072		$ 1,597,072	$ 480,801	18,500	5,569
2071	Year 44		$ 1,597,072	$ 30,000	$ 1,627,072	$ 478,212	18,500	5,437
2072	Year 45		$ 1,597,072	$ 600	$ 1,597,672	$ 458,432	18,500	5,308
2073	Year 46		$ 1,597,072		$ 1,597,072	$ 447,388	18,500	5,182
2074	Year 47		$ 1,597,072		$ 1,597,072	$ 436,774	18,500	5,059
2075	Year 48		$ 1,597,072		$ 1,597,072	$ 426,413	18,500	4,939
2076	Year 49		$ 1,597,072		$ 1,597,072	$ 416,297	18,500	4,822
2077	Year 50		$ 1,597,072	$ 408,450	$ 2,005,522	$ 510,362	18,500	4,708
2078	Year 51		$ 1,597,072		$ 1,597,072	$ 396,779	18,500	4,596
2079	Year 52		$ 1,597,072		$ 1,597,072	$ 387,366	18,500	4,487
2080	Year 53		$ 1,597,072		$ 1,597,072	$ 378,176	18,500	4,381
2081	Year 54		$ 1,597,072		$ 1,597,072	$ 369,204	18,500	4,277
2082	Year 55		$ 1,597,072		$ 1,597,072	$ 360,446	18,500	4,175
2083	Year 56		$ 1,597,072		$ 1,597,072	$ 351,895	18,500	4,076
2084	Year 57		$ 1,597,072		$ 1,597,072	$ 343,546	18,500	3,980
2085	Year 58		$ 1,597,072		$ 1,597,072	$ 335,396	18,500	3,885
2086	Year 59		$ 1,597,072		$ 1,597,072	$ 327,439	18,500	3,793
2087	Year 60		$ 1,597,072	$ 512,018	$ 2,109,090	$ 422,157	18,500	3,703
2088	Year 61		$ 1,597,072		$ 1,597,072	$ 312,088	18,500	3,615
2089	Year 62		$ 1,597,072		$ 1,597,072	$ 304,684	18,500	3,529
2090	Year 63		$ 1,597,072		$ 1,597,072	$ 297,456	18,500	3,446
2091	Year 64		$ 1,597,072		$ 1,597,072	$ 290,399	18,500	3,364
2092	Year 65		$ 1,597,072		$ 1,597,072	$ 283,510	18,500	3,284
2093	Year 66		$ 1,597,072	$ 30,000	$ 1,627,072	$ 281,983	18,500	3,206
2094	Year 67		$ 1,597,072		$ 1,597,072	$ 270,218	18,500	3,130
2095	Year 68		$ 1,597,072		$ 1,597,072	$ 263,807	18,500	3,056
2096	Year 69		$ 1,597,072		$ 1,597,072	$ 257,549	18,500	2,983
2097	Year 70		$ 1,597,072	$ 18,450	$ 1,615,522	$ 254,343	18,500	2,913
2098	Year 71		$ 1,597,072		$ 1,597,072	$ 245,474	18,500	2,843
2099	Year 72		$ 1,597,072		$ 1,597,072	$ 239,650	18,500	2,776
2100	Year 73		$ 1,597,072		$ 1,597,072	$ 233,965	18,500	2,710
2101	Year 74		$ 1,597,072		$ 1,597,072	$ 228,414	18,500	2,646
2102	Year 75		$ 1,597,072	$ 390,600	$ 1,987,672	$ 277,534	18,500	2,583
2103	Year 76		$ 1,597,072		$ 1,597,072	$ 217,705	18,500	2,522
2104	Year 77		$ 1,597,072		$ 1,597,072	$ 212,541	18,500	2,462
2105	Year 78		$ 1,597,072		$ 1,597,072	$ 207,498	18,500	2,404
2106	Year 79		$ 1,597,072		$ 1,597,072	$ 202,576	18,500	2,347
2107	Year 80		$ 1,597,072	$ 377,018	$ 1,974,090	$ 244,457	18,500	2,291
2108	Year 81		$ 1,597,072		$ 1,597,072	$ 193,078	18,500	2,237
2109	Year 82		$ 1,597,072		$ 1,597,072	$ 188,498	18,500	2,184
2110	Year 83		$ 1,597,072		$ 1,597,072	$ 184,026	18,500	2,132
2111	Year 84		$ 1,597,072		$ 1,597,072	$ 179,660	18,500	2,081
2112	Year 85		$ 1,597,072		$ 1,597,072	$ 175,398	18,500	2,032
2113	Year 86		$ 1,597,072		$ 1,597,072	$ 171,237	18,500	1,984
2114	Year 87		$ 1,597,072		$ 1,597,072	$ 167,175	18,500	1,936
2115	Year 88		$ 1,597,072	$ 30,000	$ 1,627,072	$ 166,274	18,500	1,891
2116	Year 89		$ 1,597,072		$ 1,597,072	$ 159,337	18,500	1,846
2117	Year 90		$ 1,597,072	$ 153,450	$ 1,750,522	$ 170,503	18,500	1,802
2118	Year 91		$ 1,597,072		$ 1,597,072	$ 151,866	18,500	1,759
2119	Year 92		$ 1,597,072		$ 1,597,072	$ 148,264	18,500	1,717
2120	Year 93		$ 1,597,072		$ 1,597,072	$ 144,746	18,500	1,677
2121	Year 94		$ 1,597,072		$ 1,597,072	$ 141,312	18,500	1,637
2122	Year 95		$ 1,597,072		$ 1,597,072	$ 137,960	18,500	1,598
2123	Year 96		$ 1,597,072		$ 1,597,072	$ 134,687	18,500	1,560
2124	Year 97		$ 1,597,072		$ 1,597,072	$ 131,492	18,500	1,523
2125	Year 98		$ 1,597,072		$ 1,597,072	$ 128,372	18,500	1,487
2126	Year 99		$ 1,597,072		$ 1,597,072	$ 125,327	18,500	1,452
2127	Year 100		$ 1,597,072	$ 767,018	$ 2,364,090	$ 181,116	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
178	139

Portfolio 2A: Extension into San Francisco Bay

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	15,563
Operator Salary/hr	$ 163.20
Yearly Cost	$ 25,398.82

Electricity Costs	
2025	23,896
2035	33,732

Treatment Costs	
2025	1,304,666
2035	1,537,741

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	1550000	100	25	25%					$ 387,500	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	5776700	100	20	4%			$ 231,068			
Valves	134400	30	-	-						$ 134,400
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	4000	15	-	-		$ 600				
Pumps (Process/Product)	55900	20	10	30%	$ 16,770		$ 55,900			
Motors	5600	20	10	30%	$ 1,680		$ 5,600			
Flow Meters	6000	20	-	-			$ 6,000			
Diffuser	1,500,000	100	20	4%			$ 60,000			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	30000	22	-	-				$ 30,000		
Evaporation Pond Liner		10	-	-						
				Totals	$ 18,450	$ 600	$ 358,568	$ 30,000	$ 390,000	$ 134,400

Portfolio 2A: Deep Water Discharge

		Estimated Costs (January 2020 Dollars)						
Year	Operations Year #	Capital Costs	O&M Cost	R&R	Total Cost	2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
100-Yr Lifecycle		$ 75,294,000	$ 148,979,242	$ 8,600,040	$ 258,053,869	$ 122,362,968	1,850,000	585,214
30-Yr Lifecycle		$ 75,294,000	$ 44,693,773	$ 2,065,808	$ 128,281,038	$ 96,988,739	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 18,823,500			$ 18,823,500	$ 17,099,826		
2025		$ 18,823,500			$ 18,823,500	$ 16,694,158		
2026		$ 18,823,500			$ 18,823,500	$ 16,298,114		
2027		$ 18,823,500			$ 18,823,500	$ 15,911,465		
2028	Year 1		$ 1,489,792		$ 1,489,792	$ 1,229,443	18,500	15,267
2029	Year 2		$ 1,489,792		$ 1,489,792	$ 1,200,276	18,500	14,905
2030	Year 3		$ 1,489,792		$ 1,489,792	$ 1,171,801	18,500	14,551
2031	Year 4		$ 1,489,792		$ 1,489,792	$ 1,144,002	18,500	14,206
2032	Year 5		$ 1,489,792		$ 1,489,792	$ 1,116,862	18,500	13,869
2033	Year 6		$ 1,489,792		$ 1,489,792	$ 1,090,367	18,500	13,540
2034	Year 7		$ 1,489,792		$ 1,489,792	$ 1,064,499	18,500	13,219
2035	Year 8		$ 1,760,551		$ 1,760,551	$ 1,228,121	18,500	12,905
2036	Year 9		$ 1,760,551		$ 1,760,551	$ 1,198,986	18,500	12,599
2037	Year 10		$ 1,760,551	$ 51,240	$ 1,811,791	$ 1,204,609	18,500	12,300
2038	Year 11		$ 1,760,551		$ 1,760,551	$ 1,142,772	18,500	12,008
2039	Year 12		$ 1,760,551		$ 1,760,551	$ 1,115,661	18,500	11,723
2040	Year 13		$ 1,760,551		$ 1,760,551	$ 1,089,194	18,500	11,445
2041	Year 14		$ 1,760,551		$ 1,760,551	$ 1,063,355	18,500	11,174
2042	Year 15		$ 1,760,551	$ 600	$ 1,761,151	$ 1,038,482	18,500	10,909
2043	Year 16		$ 1,760,551		$ 1,760,551	$ 1,013,500	18,500	10,650
2044	Year 17		$ 1,760,551		$ 1,760,551	$ 989,456	18,500	10,397
2045	Year 18		$ 1,760,551		$ 1,760,551	$ 965,983	18,500	10,151
2046	Year 19		$ 1,760,551		$ 1,760,551	$ 943,066	18,500	9,910
2047	Year 20		$ 1,760,551	$ 987,328	$ 2,747,879	$ 1,437,024	18,500	9,675
2048	Year 21		$ 1,760,551		$ 1,760,551	$ 898,851	18,500	9,445
2049	Year 22		$ 1,760,551	$ 89,200	$ 1,849,751	$ 921,988	18,500	9,221
2050	Year 23		$ 1,760,551		$ 1,760,551	$ 856,709	18,500	9,002
2051	Year 24		$ 1,760,551		$ 1,760,551	$ 836,385	18,500	8,789
2052	Year 25		$ 1,760,551	$ 390,000	$ 2,150,551	$ 997,425	18,500	8,580
2053	Year 26		$ 1,760,551		$ 1,760,551	$ 797,172	18,500	8,377
2054	Year 27		$ 1,760,551		$ 1,760,551	$ 778,260	18,500	8,178
2055	Year 28		$ 1,760,551		$ 1,760,551	$ 759,797	18,500	7,984
2056	Year 29		$ 1,760,551		$ 1,760,551	$ 741,772	18,500	7,795
2057	Year 30		$ 1,760,551	$ 547,440	$ 2,307,991	$ 949,355	18,500	7,610
2058	Year 31		$ 1,760,551		$ 1,760,551	$ 706,995	18,500	7,429
2059	Year 32		$ 1,760,551		$ 1,760,551	$ 690,222	18,500	7,253
2060	Year 33		$ 1,760,551		$ 1,760,551	$ 673,848	18,500	7,081
2061	Year 34		$ 1,760,551		$ 1,760,551	$ 657,862	18,500	6,913
2062	Year 35		$ 1,760,551		$ 1,760,551	$ 642,255	18,500	6,749
2063	Year 36		$ 1,760,551		$ 1,760,551	$ 627,018	18,500	6,589
2064	Year 37		$ 1,760,551		$ 1,760,551	$ 612,143	18,500	6,432
2065	Year 38		$ 1,760,551		$ 1,760,551	$ 597,621	18,500	6,280
2066	Year 39		$ 1,760,551		$ 1,760,551	$ 583,443	18,500	6,131
2067	Year 40		$ 1,760,551	$ 987,328	$ 2,747,879	$ 889,038	18,500	5,985
2068	Year 41		$ 1,760,551		$ 1,760,551	$ 556,089	18,500	5,843
2069	Year 42		$ 1,760,551		$ 1,760,551	$ 542,897	18,500	5,705
2070	Year 43		$ 1,760,551		$ 1,760,551	$ 530,017	18,500	5,569
2071	Year 44		$ 1,760,551	$ 89,200	$ 1,849,751	$ 543,660	18,500	5,437
2072	Year 45		$ 1,760,551	$ 600	$ 1,761,151	$ 505,340	18,500	5,308
2073	Year 46		$ 1,760,551		$ 1,760,551	$ 493,184	18,500	5,182
2074	Year 47		$ 1,760,551		$ 1,760,551	$ 481,483	18,500	5,059
2075	Year 48		$ 1,760,551		$ 1,760,551	$ 470,061	18,500	4,939
2076	Year 49		$ 1,760,551		$ 1,760,551	$ 458,909	18,500	4,822
2077	Year 50		$ 1,760,551	$ 441,240	$ 2,201,791	$ 560,309	18,500	4,708
2078	Year 51		$ 1,760,551		$ 1,760,551	$ 437,394	18,500	4,596
2079	Year 52		$ 1,760,551		$ 1,760,551	$ 427,017	18,500	4,487
2080	Year 53		$ 1,760,551		$ 1,760,551	$ 416,887	18,500	4,381
2081	Year 54		$ 1,760,551		$ 1,760,551	$ 406,997	18,500	4,277
2082	Year 55		$ 1,760,551		$ 1,760,551	$ 397,342	18,500	4,175
2083	Year 56		$ 1,760,551		$ 1,760,551	$ 387,915	18,500	4,076
2084	Year 57		$ 1,760,551		$ 1,760,551	$ 378,713	18,500	3,980
2085	Year 58		$ 1,760,551		$ 1,760,551	$ 369,728	18,500	3,885
2086	Year 59		$ 1,760,551		$ 1,760,551	$ 360,957	18,500	3,793
2087	Year 60		$ 1,760,551	$ 1,483,528	$ 3,244,079	$ 649,338	18,500	3,703
2088	Year 61		$ 1,760,551		$ 1,760,551	$ 344,034	18,500	3,615
2089	Year 62		$ 1,760,551		$ 1,760,551	$ 335,872	18,500	3,529
2090	Year 63		$ 1,760,551		$ 1,760,551	$ 327,904	18,500	3,446
2091	Year 64		$ 1,760,551		$ 1,760,551	$ 320,125	18,500	3,364
2092	Year 65		$ 1,760,551		$ 1,760,551	$ 312,530	18,500	3,284
2093	Year 66		$ 1,760,551	$ 89,200	$ 1,849,751	$ 320,575	18,500	3,206
2094	Year 67		$ 1,760,551		$ 1,760,551	$ 297,878	18,500	3,130
2095	Year 68		$ 1,760,551		$ 1,760,551	$ 290,811	18,500	3,056
2096	Year 69		$ 1,760,551		$ 1,760,551	$ 283,912	18,500	2,983
2097	Year 70		$ 1,760,551	$ 51,240	$ 1,811,791	$ 285,244	18,500	2,913
2098	Year 71		$ 1,760,551		$ 1,760,551	$ 270,601	18,500	2,843
2099	Year 72		$ 1,760,551		$ 1,760,551	$ 264,181	18,500	2,776
2100	Year 73		$ 1,760,551		$ 1,760,551	$ 257,914	18,500	2,710
2101	Year 74		$ 1,760,551		$ 1,760,551	$ 251,795	18,500	2,646
2102	Year 75		$ 1,760,551	$ 390,600	$ 2,151,151	$ 300,361	18,500	2,583
2103	Year 76		$ 1,760,551		$ 1,760,551	$ 239,990	18,500	2,522
2104	Year 77		$ 1,760,551		$ 1,760,551	$ 234,297	18,500	2,462
2105	Year 78		$ 1,760,551		$ 1,760,551	$ 228,738	18,500	2,404
2106	Year 79		$ 1,760,551		$ 1,760,551	$ 223,312	18,500	2,347
2107	Year 80		$ 1,760,551	$ 987,328	$ 2,747,879	$ 340,278	18,500	2,291
2108	Year 81		$ 1,760,551		$ 1,760,551	$ 212,842	18,500	2,237
2109	Year 82		$ 1,760,551		$ 1,760,551	$ 207,793	18,500	2,184
2110	Year 83		$ 1,760,551		$ 1,760,551	$ 202,863	18,500	2,132
2111	Year 84		$ 1,760,551		$ 1,760,551	$ 198,051	18,500	2,081
2112	Year 85		$ 1,760,551		$ 1,760,551	$ 193,352	18,500	2,032
2113	Year 86		$ 1,760,551		$ 1,760,551	$ 188,765	18,500	1,984
2114	Year 87		$ 1,760,551		$ 1,760,551	$ 184,287	18,500	1,936
2115	Year 88		$ 1,760,551	$ 89,200	$ 1,849,751	$ 189,031	18,500	1,891
2116	Year 89		$ 1,760,551		$ 1,760,551	$ 175,647	18,500	1,846
2117	Year 90		$ 1,760,551	$ 547,440	$ 2,307,991	$ 224,801	18,500	1,802
2118	Year 91		$ 1,760,551		$ 1,760,551	$ 167,412	18,500	1,759
2119	Year 92		$ 1,760,551		$ 1,760,551	$ 163,440	18,500	1,717
2120	Year 93		$ 1,760,551		$ 1,760,551	$ 159,563	18,500	1,677
2121	Year 94		$ 1,760,551		$ 1,760,551	$ 155,777	18,500	1,637
2122	Year 95		$ 1,760,551		$ 1,760,551	$ 152,082	18,500	1,598
2123	Year 96		$ 1,760,551		$ 1,760,551	$ 148,474	18,500	1,560
2124	Year 97		$ 1,760,551		$ 1,760,551	$ 144,952	18,500	1,523
2125	Year 98		$ 1,760,551		$ 1,760,551	$ 141,513	18,500	1,487
2126	Year 99		$ 1,760,551		$ 1,760,551	$ 138,156	18,500	1,452
2127	Year 100		$ 1,760,551	$ 1,377,328	$ 3,137,879	$ 240,397	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
294	209

Portfolio 2A: Deep Water Discharge

O&M COSTS

	Consumables		
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	70,257
Operator Salary/hr	$ 163.20
Yearly Cost	$ 114,659.42

Electricity Costs	
2025	70,267
2035	107,951

Treatment Costs	
2025	1,304,666
2035	1,537,741

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	1,550,000	100	25	25%					$ 387,500	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	18982200	100	20	4%			$ 759,288			
Valves	495600	30	-	-						$ 495,600
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	4000	15	-	-		$ 600				
Pumps (Process/Product)	148700	20	10	30%	$ 44,610		$ 148,700			
Motors	22100	20	10	30%	$ 6,630		$ 22,100			
Flow Meters	6000	20	-	-			$ 6,000			
Diffuser		100	20	4%			$ -			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	89,200	22	-	-				$ 89,200		
Evaporation Pond Liner		10	-	-						
				Totals	$ 51,240	$ 600	$ 936,088	$ 89,200	$ 390,000	$ 495,600

Portfolio 2B: Extension into Guadalupe Slough

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 38,322,000	$ 139,680,632	$ 5,180,985	$ 206,588,648	$ 85,660,920	1,850,000	585,214
30-Yr Lifecycle		$ 38,322,000	$ 41,904,190	$ 1,263,597	$ 87,278,128	$ 62,288,384	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 9,580,500			$ 9,580,500	$ 8,703,210		
2025		$ 9,580,500			$ 9,580,500	$ 8,496,740		
2026		$ 9,580,500			$ 9,580,500	$ 8,295,167		
2027		$ 9,580,500			$ 9,580,500	$ 8,098,377		
2028	Year 1		$ 1,396,806		$ 1,396,806	$ 1,152,707	18,500	15,267
2029	Year 2		$ 1,396,806		$ 1,396,806	$ 1,125,360	18,500	14,905
2030	Year 3		$ 1,396,806		$ 1,396,806	$ 1,098,663	18,500	14,551
2031	Year 4		$ 1,396,806		$ 1,396,806	$ 1,072,599	18,500	14,206
2032	Year 5		$ 1,396,806		$ 1,396,806	$ 1,047,153	18,500	13,869
2033	Year 6		$ 1,396,806		$ 1,396,806	$ 1,022,311	18,500	13,540
2034	Year 7		$ 1,396,806		$ 1,396,806	$ 998,058	18,500	13,219
2035	Year 8		$ 1,648,473		$ 1,648,473	$ 1,149,938	18,500	12,905
2036	Year 9		$ 1,648,473		$ 1,648,473	$ 1,122,657	18,500	12,599
2037	Year 10		$ 1,648,473	$ 37,680	$ 1,686,153	$ 1,121,076	18,500	12,300
2038	Year 11		$ 1,648,473		$ 1,648,473	$ 1,070,022	18,500	12,008
2039	Year 12		$ 1,648,473		$ 1,648,473	$ 1,044,638	18,500	11,723
2040	Year 13		$ 1,648,473		$ 1,648,473	$ 1,019,855	18,500	11,445
2041	Year 14		$ 1,648,473		$ 1,648,473	$ 995,661	18,500	11,174
2042	Year 15		$ 1,648,473	$ 600	$ 1,649,073	$ 972,394	18,500	10,909
2043	Year 16		$ 1,648,473		$ 1,648,473	$ 948,980	18,500	10,650
2044	Year 17		$ 1,648,473		$ 1,648,473	$ 926,467	18,500	10,397
2045	Year 18		$ 1,648,473		$ 1,648,473	$ 904,488	18,500	10,151
2046	Year 19		$ 1,648,473		$ 1,648,473	$ 883,030	18,500	9,910
2047	Year 20		$ 1,648,473	$ 487,037	$ 2,135,510	$ 1,116,781	18,500	9,675
2048	Year 21		$ 1,648,473		$ 1,648,473	$ 841,630	18,500	9,445
2049	Year 22		$ 1,648,473	$ 63,800	$ 1,712,273	$ 853,464	18,500	9,221
2050	Year 23		$ 1,648,473		$ 1,648,473	$ 802,171	18,500	9,002
2051	Year 24		$ 1,648,473		$ 1,648,473	$ 783,140	18,500	8,789
2052	Year 25		$ 1,648,473	$ 390,000	$ 2,038,473	$ 945,443	18,500	8,580
2053	Year 26		$ 1,648,473		$ 1,648,473	$ 746,423	18,500	8,377
2054	Year 27		$ 1,648,473		$ 1,648,473	$ 728,716	18,500	8,178
2055	Year 28		$ 1,648,473		$ 1,648,473	$ 711,428	18,500	7,984
2056	Year 29		$ 1,648,473		$ 1,648,473	$ 694,550	18,500	7,795
2057	Year 30		$ 1,648,473	$ 284,480	$ 1,932,953	$ 795,089	18,500	7,610
2058	Year 31		$ 1,648,473		$ 1,648,473	$ 661,987	18,500	7,429
2059	Year 32		$ 1,648,473		$ 1,648,473	$ 646,282	18,500	7,253
2060	Year 33		$ 1,648,473		$ 1,648,473	$ 630,950	18,500	7,081
2061	Year 34		$ 1,648,473		$ 1,648,473	$ 615,982	18,500	6,913
2062	Year 35		$ 1,648,473		$ 1,648,473	$ 601,368	18,500	6,749
2063	Year 36		$ 1,648,473		$ 1,648,473	$ 587,102	18,500	6,589
2064	Year 37		$ 1,648,473		$ 1,648,473	$ 573,174	18,500	6,432
2065	Year 38		$ 1,648,473		$ 1,648,473	$ 559,576	18,500	6,280
2066	Year 39		$ 1,648,473		$ 1,648,473	$ 546,301	18,500	6,131
2067	Year 40		$ 1,648,473	$ 487,037	$ 2,135,510	$ 690,915	18,500	5,985
2068	Year 41		$ 1,648,473		$ 1,648,473	$ 520,688	18,500	5,843
2069	Year 42		$ 1,648,473		$ 1,648,473	$ 508,336	18,500	5,705
2070	Year 43		$ 1,648,473		$ 1,648,473	$ 496,276	18,500	5,569
2071	Year 44		$ 1,648,473	$ 63,800	$ 1,712,273	$ 503,254	18,500	5,437
2072	Year 45		$ 1,648,473	$ 600	$ 1,649,073	$ 473,181	18,500	5,308
2073	Year 46		$ 1,648,473		$ 1,648,473	$ 461,787	18,500	5,182
2074	Year 47		$ 1,648,473		$ 1,648,473	$ 450,832	18,500	5,059
2075	Year 48		$ 1,648,473		$ 1,648,473	$ 440,137	18,500	4,939
2076	Year 49		$ 1,648,473		$ 1,648,473	$ 429,695	18,500	4,822
2077	Year 50		$ 1,648,473	$ 427,680	$ 2,076,153	$ 528,336	18,500	4,708
2078	Year 51		$ 1,648,473		$ 1,648,473	$ 409,549	18,500	4,596
2079	Year 52		$ 1,648,473		$ 1,648,473	$ 399,833	18,500	4,487
2080	Year 53		$ 1,648,473		$ 1,648,473	$ 390,348	18,500	4,381
2081	Year 54		$ 1,648,473		$ 1,648,473	$ 381,087	18,500	4,277
2082	Year 55		$ 1,648,473		$ 1,648,473	$ 372,046	18,500	4,175
2083	Year 56		$ 1,648,473		$ 1,648,473	$ 363,220	18,500	4,076
2084	Year 57		$ 1,648,473		$ 1,648,473	$ 354,603	18,500	3,980
2085	Year 58		$ 1,648,473		$ 1,648,473	$ 346,191	18,500	3,885
2086	Year 59		$ 1,648,473		$ 1,648,473	$ 337,978	18,500	3,793
2087	Year 60		$ 1,648,473	$ 733,837	$ 2,382,310	$ 476,846	18,500	3,703
2088	Year 61		$ 1,648,473		$ 1,648,473	$ 322,132	18,500	3,615
2089	Year 62		$ 1,648,473		$ 1,648,473	$ 314,490	18,500	3,529
2090	Year 63		$ 1,648,473		$ 1,648,473	$ 307,029	18,500	3,446
2091	Year 64		$ 1,648,473		$ 1,648,473	$ 299,745	18,500	3,364
2092	Year 65		$ 1,648,473		$ 1,648,473	$ 292,634	18,500	3,284
2093	Year 66		$ 1,648,473	$ 63,800	$ 1,712,273	$ 296,749	18,500	3,206
2094	Year 67		$ 1,648,473		$ 1,648,473	$ 278,915	18,500	3,130
2095	Year 68		$ 1,648,473		$ 1,648,473	$ 272,298	18,500	3,056
2096	Year 69		$ 1,648,473		$ 1,648,473	$ 265,838	18,500	2,983
2097	Year 70		$ 1,648,473	$ 37,680	$ 1,686,153	$ 265,463	18,500	2,913
2098	Year 71		$ 1,648,473		$ 1,648,473	$ 253,374	18,500	2,843
2099	Year 72		$ 1,648,473		$ 1,648,473	$ 247,363	18,500	2,776
2100	Year 73		$ 1,648,473		$ 1,648,473	$ 241,495	18,500	2,710
2101	Year 74		$ 1,648,473		$ 1,648,473	$ 235,766	18,500	2,646
2102	Year 75		$ 1,648,473	$ 390,600	$ 2,039,073	$ 284,711	18,500	2,583
2103	Year 76		$ 1,648,473		$ 1,648,473	$ 224,712	18,500	2,522
2104	Year 77		$ 1,648,473		$ 1,648,473	$ 219,381	18,500	2,462
2105	Year 78		$ 1,648,473		$ 1,648,473	$ 214,177	18,500	2,404
2106	Year 79		$ 1,648,473		$ 1,648,473	$ 209,096	18,500	2,347
2107	Year 80		$ 1,648,473	$ 487,037	$ 2,135,510	$ 264,446	18,500	2,291
2108	Year 81		$ 1,648,473		$ 1,648,473	$ 199,292	18,500	2,237
2109	Year 82		$ 1,648,473		$ 1,648,473	$ 194,564	18,500	2,184
2110	Year 83		$ 1,648,473		$ 1,648,473	$ 189,949	18,500	2,132
2111	Year 84		$ 1,648,473		$ 1,648,473	$ 185,442	18,500	2,081
2112	Year 85		$ 1,648,473		$ 1,648,473	$ 181,043	18,500	2,032
2113	Year 86		$ 1,648,473		$ 1,648,473	$ 176,748	18,500	1,984
2114	Year 87		$ 1,648,473		$ 1,648,473	$ 172,555	18,500	1,936
2115	Year 88		$ 1,648,473	$ 63,800	$ 1,712,273	$ 174,981	18,500	1,891
2116	Year 89		$ 1,648,473		$ 1,648,473	$ 164,465	18,500	1,846
2117	Year 90		$ 1,648,473	$ 284,480	$ 1,932,953	$ 188,272	18,500	1,802
2118	Year 91		$ 1,648,473		$ 1,648,473	$ 156,754	18,500	1,759
2119	Year 92		$ 1,648,473		$ 1,648,473	$ 153,035	18,500	1,717
2120	Year 93		$ 1,648,473		$ 1,648,473	$ 149,405	18,500	1,677
2121	Year 94		$ 1,648,473		$ 1,648,473	$ 145,860	18,500	1,637
2122	Year 95		$ 1,648,473		$ 1,648,473	$ 142,400	18,500	1,598
2123	Year 96		$ 1,648,473		$ 1,648,473	$ 139,022	18,500	1,560
2124	Year 97		$ 1,648,473		$ 1,648,473	$ 135,724	18,500	1,523
2125	Year 98		$ 1,648,473		$ 1,648,473	$ 132,504	18,500	1,487
2126	Year 99		$ 1,648,473		$ 1,648,473	$ 129,360	18,500	1,452
2127	Year 100		$ 1,648,473	$ 877,037	$ 2,525,510	$ 193,482	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
189	146

Portfolio 2B: Extension into Guadalupe Slough

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cos	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	32,760
Operator Salary/hr	$ 163.20
Yearly Cost	$ 53,464.32

Electricity Costs	
2025	38,476
2035	57,068

Treatment Costs	
2025	1,304,666
2035	1,537,741

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	1550000	100	25	25%					$ 387,500	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	7,443,924	100	20	4%			$ 297,757			
Valves	246200	30	-	-						$ 246,200
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	4000	15	-	-		$ 600				
Pumps (Process/Product)	109400	20	10	30%	$ 32,820		$ 109,400			
Motors	16200	20	10	30%	$ 4,860		$ 16,200			
Flow Meters	6000	20	-	-			$ 6,000			
Diffuser	500000	100	20	4%			$ 20,000			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	63800	22	-	-				$ 63,800		
Evaporation Pond Liner		10	-	-						
				Totals	$ 37,680	$ 600	$ 449,357	$ 63,800	$ 390,000	$ 246,200

Portfolio 4: Blending with Palo Alto Effluent and Extension to Guadalupe Slough

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 41,833,000	$ 140,375,789	$ 6,076,943	$ 211,630,127	$ 89,161,072	1,850,000	585,214
30-Yr Lifecycle		$ 41,833,000	$ 42,112,737	$ 1,453,909	$ 91,172,990	$ 65,582,593	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 10,458,250			$ 10,458,250	$ 9,500,585		
2025		$ 10,458,250			$ 10,458,250	$ 9,275,197		
2026		$ 10,458,250			$ 10,458,250	$ 9,055,157		
2027		$ 10,458,250			$ 10,458,250	$ 8,840,337		
2028	Year 1		$ 1,403,758		$ 1,403,758	$ 1,158,443	18,500	15,267
2029	Year 2		$ 1,403,758		$ 1,403,758	$ 1,130,961	18,500	14,905
2030	Year 3		$ 1,403,758		$ 1,403,758	$ 1,104,131	18,500	14,551
2031	Year 4		$ 1,403,758		$ 1,403,758	$ 1,077,937	18,500	14,206
2032	Year 5		$ 1,403,758		$ 1,403,758	$ 1,052,364	18,500	13,869
2033	Year 6		$ 1,403,758		$ 1,403,758	$ 1,027,399	18,500	13,540
2034	Year 7		$ 1,403,758		$ 1,403,758	$ 1,003,025	18,500	13,219
2035	Year 8		$ 1,654,773		$ 1,654,773	$ 1,154,332	18,500	12,905
2036	Year 9		$ 1,654,773		$ 1,654,773	$ 1,126,947	18,500	12,599
2037	Year 10		$ 1,654,773	$ 51,180	$ 1,705,953	$ 1,134,240	18,500	12,300
2038	Year 11		$ 1,654,773		$ 1,654,773	$ 1,074,111	18,500	12,008
2039	Year 12		$ 1,654,773		$ 1,654,773	$ 1,048,630	18,500	11,723
2040	Year 13		$ 1,654,773		$ 1,654,773	$ 1,023,752	18,500	11,445
2041	Year 14		$ 1,654,773		$ 1,654,773	$ 999,465	18,500	11,174
2042	Year 15		$ 1,654,773	$ 1,200	$ 1,655,973	$ 976,462	18,500	10,909
2043	Year 16		$ 1,654,773		$ 1,654,773	$ 952,606	18,500	10,650
2044	Year 17		$ 1,654,773		$ 1,654,773	$ 930,007	18,500	10,397
2045	Year 18		$ 1,654,773		$ 1,654,773	$ 907,944	18,500	10,151
2046	Year 19		$ 1,654,773		$ 1,654,773	$ 886,404	18,500	9,910
2047	Year 20		$ 1,654,773	$ 529,449	$ 2,184,221	$ 1,142,255	18,500	9,675
2048	Year 21		$ 1,654,773		$ 1,654,773	$ 844,846	18,500	9,445
2049	Year 22		$ 1,654,773	$ 80,000	$ 1,734,773	$ 864,678	18,500	9,221
2050	Year 23		$ 1,654,773		$ 1,654,773	$ 805,236	18,500	9,002
2051	Year 24		$ 1,654,773		$ 1,654,773	$ 786,133	18,500	8,789
2052	Year 25		$ 1,654,773	$ 627,500	$ 2,282,273	$ 1,058,518	18,500	8,580
2053	Year 26		$ 1,654,773		$ 1,654,773	$ 749,276	18,500	8,377
2054	Year 27		$ 1,654,773		$ 1,654,773	$ 731,500	18,500	8,178
2055	Year 28		$ 1,654,773		$ 1,654,773	$ 714,147	18,500	7,984
2056	Year 29		$ 1,654,773		$ 1,654,773	$ 697,204	18,500	7,795
2057	Year 30		$ 1,654,773	$ 164,580	$ 1,819,353	$ 748,362	18,500	7,610
2058	Year 31		$ 1,654,773		$ 1,654,773	$ 664,517	18,500	7,429
2059	Year 32		$ 1,654,773		$ 1,654,773	$ 648,752	18,500	7,253
2060	Year 33		$ 1,654,773		$ 1,654,773	$ 633,361	18,500	7,081
2061	Year 34		$ 1,654,773		$ 1,654,773	$ 618,336	18,500	6,913
2062	Year 35		$ 1,654,773		$ 1,654,773	$ 603,667	18,500	6,749
2063	Year 36		$ 1,654,773		$ 1,654,773	$ 589,345	18,500	6,589
2064	Year 37		$ 1,654,773		$ 1,654,773	$ 575,364	18,500	6,432
2065	Year 38		$ 1,654,773		$ 1,654,773	$ 561,714	18,500	6,280
2066	Year 39		$ 1,654,773		$ 1,654,773	$ 548,389	18,500	6,131
2067	Year 40		$ 1,654,773	$ 529,449	$ 2,184,221	$ 706,675	18,500	5,985
2068	Year 41		$ 1,654,773		$ 1,654,773	$ 522,678	18,500	5,843
2069	Year 42		$ 1,654,773		$ 1,654,773	$ 510,278	18,500	5,705
2070	Year 43		$ 1,654,773		$ 1,654,773	$ 498,173	18,500	5,569
2071	Year 44		$ 1,654,773	$ 80,000	$ 1,734,773	$ 509,867	18,500	5,437
2072	Year 45		$ 1,654,773	$ 1,200	$ 1,655,973	$ 475,160	18,500	5,308
2073	Year 46		$ 1,654,773		$ 1,654,773	$ 463,552	18,500	5,182
2074	Year 47		$ 1,654,773		$ 1,654,773	$ 452,555	18,500	5,059
2075	Year 48		$ 1,654,773		$ 1,654,773	$ 441,819	18,500	4,939
2076	Year 49		$ 1,654,773		$ 1,654,773	$ 431,337	18,500	4,822
2077	Year 50		$ 1,654,773	$ 678,680	$ 2,333,453	$ 593,814	18,500	4,708
2078	Year 51		$ 1,654,773		$ 1,654,773	$ 411,114	18,500	4,596
2079	Year 52		$ 1,654,773		$ 1,654,773	$ 401,361	18,500	4,487
2080	Year 53		$ 1,654,773		$ 1,654,773	$ 391,839	18,500	4,381
2081	Year 54		$ 1,654,773		$ 1,654,773	$ 382,544	18,500	4,277
2082	Year 55		$ 1,654,773		$ 1,654,773	$ 373,468	18,500	4,175
2083	Year 56		$ 1,654,773		$ 1,654,773	$ 364,608	18,500	4,076
2084	Year 57		$ 1,654,773		$ 1,654,773	$ 355,958	18,500	3,980
2085	Year 58		$ 1,654,773		$ 1,654,773	$ 347,514	18,500	3,885
2086	Year 59		$ 1,654,773		$ 1,654,773	$ 339,270	18,500	3,793
2087	Year 60		$ 1,654,773	$ 642,849	$ 2,297,621	$ 459,894	18,500	3,703
2088	Year 61		$ 1,654,773		$ 1,654,773	$ 323,363	18,500	3,615
2089	Year 62		$ 1,654,773		$ 1,654,773	$ 315,692	18,500	3,529
2090	Year 63		$ 1,654,773		$ 1,654,773	$ 308,203	18,500	3,446
2091	Year 64		$ 1,654,773		$ 1,654,773	$ 300,891	18,500	3,364
2092	Year 65		$ 1,654,773		$ 1,654,773	$ 293,753	18,500	3,284
2093	Year 66		$ 1,654,773	$ 80,000	$ 1,734,773	$ 300,648	18,500	3,206
2094	Year 67		$ 1,654,773		$ 1,654,773	$ 279,980	18,500	3,130
2095	Year 68		$ 1,654,773		$ 1,654,773	$ 273,338	18,500	3,056
2096	Year 69		$ 1,654,773		$ 1,654,773	$ 266,854	18,500	2,983
2097	Year 70		$ 1,654,773	$ 51,180	$ 1,705,953	$ 268,581	18,500	2,913
2098	Year 71		$ 1,654,773		$ 1,654,773	$ 254,342	18,500	2,843
2099	Year 72		$ 1,654,773		$ 1,654,773	$ 248,309	18,500	2,776
2100	Year 73		$ 1,654,773		$ 1,654,773	$ 242,418	18,500	2,710
2101	Year 74		$ 1,654,773		$ 1,654,773	$ 236,667	18,500	2,646
2102	Year 75		$ 1,654,773	$ 628,700	$ 2,283,473	$ 318,836	18,500	2,583
2103	Year 76		$ 1,654,773		$ 1,654,773	$ 225,571	18,500	2,522
2104	Year 77		$ 1,654,773		$ 1,654,773	$ 220,220	18,500	2,462
2105	Year 78		$ 1,654,773		$ 1,654,773	$ 214,995	18,500	2,404
2106	Year 79		$ 1,654,773		$ 1,654,773	$ 209,895	18,500	2,347
2107	Year 80		$ 1,654,773	$ 529,449	$ 2,184,221	$ 270,478	18,500	2,291
2108	Year 81		$ 1,654,773		$ 1,654,773	$ 200,054	18,500	2,237
2109	Year 82		$ 1,654,773		$ 1,654,773	$ 195,308	18,500	2,184
2110	Year 83		$ 1,654,773		$ 1,654,773	$ 190,675	18,500	2,132
2111	Year 84		$ 1,654,773		$ 1,654,773	$ 186,151	18,500	2,081
2112	Year 85		$ 1,654,773		$ 1,654,773	$ 181,735	18,500	2,032
2113	Year 86		$ 1,654,773		$ 1,654,773	$ 177,424	18,500	1,984
2114	Year 87		$ 1,654,773		$ 1,654,773	$ 173,214	18,500	1,936
2115	Year 88		$ 1,654,773	$ 80,000	$ 1,734,773	$ 177,281	18,500	1,891
2116	Year 89		$ 1,654,773		$ 1,654,773	$ 165,093	18,500	1,846
2117	Year 90		$ 1,654,773	$ 164,580	$ 1,819,353	$ 177,207	18,500	1,802
2118	Year 91		$ 1,654,773		$ 1,654,773	$ 157,353	18,500	1,759
2119	Year 92		$ 1,654,773		$ 1,654,773	$ 153,620	18,500	1,717
2120	Year 93		$ 1,654,773		$ 1,654,773	$ 149,976	18,500	1,677
2121	Year 94		$ 1,654,773		$ 1,654,773	$ 146,418	18,500	1,637
2122	Year 95		$ 1,654,773		$ 1,654,773	$ 142,944	18,500	1,598
2123	Year 96		$ 1,654,773		$ 1,654,773	$ 139,553	18,500	1,560
2124	Year 97		$ 1,654,773		$ 1,654,773	$ 136,242	18,500	1,523
2125	Year 98		$ 1,654,773		$ 1,654,773	$ 133,010	18,500	1,487
2126	Year 99		$ 1,654,773		$ 1,654,773	$ 129,855	18,500	1,452
2127	Year 100		$ 1,654,773	$ 1,156,949	$ 2,811,721	$ 215,409	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
199	152

Portfolio 4: Blending with Palo Alto Effluent and Extension to Guadalupe Slough

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	20000	2%	$ 400
		Total Consumables	$ 400.00

Operator Costs	
Pipelength	43,609
Operator Salary/hr	$ 163.20
Yearly Cost	$ 71,169.89

Electricity Costs	
2025	30,222
2035	45,983

Treatment Costs	
2025	1,301,966
2035	1,537,220

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	2500000	100	25	25%					$ 625,000	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	6891715	100	20	4%			$ 275,669			
Valves	112200	30	-	-						$ 112,200
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	8000	15	-	-		$ 1,200				
Pumps (Process/Product)	153700	20	10	30%	$ 46,110		$ 153,700			
Motors	16900	20	10	30%	$ 5,070		$ 16,900			
Flow Meters	12000	20	-	-			$ 12,000			
Diffuser	500000	100	20	4%			$ 20,000			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	80000	22	-	-				$ 80,000		
Evaporation Pond Liner		10	-	-						
				Totals	$ 51,180	$ 1,200	$ 478,269	$ 80,000	$ 627,500	$ 112,200

Portfolio 4: Extension into San Francisco Bay and Extension to Guadalupe Slough

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 58,788,000	$ 141,558,914	$ 6,733,823	$ 230,570,026	$ 104,600,010	1,850,000	585,214
30-Yr Lifecycle		$ 58,788,000	$ 42,467,674	$ 1,614,705	$ 108,679,558	$ 80,752,136	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 14,697,000			$ 14,697,000	$ 13,351,191		
2025		$ 14,697,000			$ 14,697,000	$ 13,034,454		
2026		$ 14,697,000			$ 14,697,000	$ 12,725,231		
2027		$ 14,697,000			$ 14,697,000	$ 12,423,343		
2028	Year 1		$ 1,415,589		$ 1,415,589	$ 1,168,207	18,500	15,267
2029	Year 2		$ 1,415,589		$ 1,415,589	$ 1,140,493	18,500	14,905
2030	Year 3		$ 1,415,589		$ 1,415,589	$ 1,113,437	18,500	14,551
2031	Year 4		$ 1,415,589		$ 1,415,589	$ 1,087,022	18,500	14,206
2032	Year 5		$ 1,415,589		$ 1,415,589	$ 1,061,234	18,500	13,869
2033	Year 6		$ 1,415,589		$ 1,415,589	$ 1,036,058	18,500	13,540
2034	Year 7		$ 1,415,589		$ 1,415,589	$ 1,011,479	18,500	13,219
2035	Year 8		$ 1,668,162		$ 1,668,162	$ 1,163,672	18,500	12,905
2036	Year 9		$ 1,668,162		$ 1,668,162	$ 1,136,066	18,500	12,599
2037	Year 10		$ 1,668,162	$ 51,180	$ 1,719,342	$ 1,143,142	18,500	12,300
2038	Year 11		$ 1,668,162		$ 1,668,162	$ 1,082,802	18,500	12,008
2039	Year 12		$ 1,668,162		$ 1,668,162	$ 1,057,114	18,500	11,723
2040	Year 13		$ 1,668,162		$ 1,668,162	$ 1,032,036	18,500	11,445
2041	Year 14		$ 1,668,162		$ 1,668,162	$ 1,007,552	18,500	11,174
2042	Year 15		$ 1,668,162	$ 1,200	$ 1,669,362	$ 984,357	18,500	10,909
2043	Year 16		$ 1,668,162		$ 1,668,162	$ 960,314	18,500	10,650
2044	Year 17		$ 1,668,162		$ 1,668,162	$ 937,532	18,500	10,397
2045	Year 18		$ 1,668,162		$ 1,668,162	$ 915,290	18,500	10,151
2046	Year 19		$ 1,668,162		$ 1,668,162	$ 893,577	18,500	9,910
2047	Year 20		$ 1,668,162	$ 615,445	$ 2,283,607	$ 1,194,229	18,500	9,675
2048	Year 21		$ 1,668,162		$ 1,668,162	$ 851,682	18,500	9,445
2049	Year 22		$ 1,668,162	$ 80,000	$ 1,748,162	$ 871,352	18,500	9,221
2050	Year 23		$ 1,668,162		$ 1,668,162	$ 811,751	18,500	9,002
2051	Year 24		$ 1,668,162		$ 1,668,162	$ 792,494	18,500	8,789
2052	Year 25		$ 1,668,162	$ 630,000	$ 2,298,162	$ 1,065,887	18,500	8,580
2053	Year 26		$ 1,668,162		$ 1,668,162	$ 755,338	18,500	8,377
2054	Year 27		$ 1,668,162		$ 1,668,162	$ 737,419	18,500	8,178
2055	Year 28		$ 1,668,162		$ 1,668,162	$ 719,925	18,500	7,984
2056	Year 29		$ 1,668,162		$ 1,668,162	$ 702,846	18,500	7,795
2057	Year 30		$ 1,668,162	$ 236,880	$ 1,905,042	$ 783,609	18,500	7,610
2058	Year 31		$ 1,668,162		$ 1,668,162	$ 669,893	18,500	7,429
2059	Year 32		$ 1,668,162		$ 1,668,162	$ 654,001	18,500	7,253
2060	Year 33		$ 1,668,162		$ 1,668,162	$ 638,486	18,500	7,081
2061	Year 34		$ 1,668,162		$ 1,668,162	$ 623,339	18,500	6,913
2062	Year 35		$ 1,668,162		$ 1,668,162	$ 608,551	18,500	6,749
2063	Year 36		$ 1,668,162		$ 1,668,162	$ 594,114	18,500	6,589
2064	Year 37		$ 1,668,162		$ 1,668,162	$ 580,020	18,500	6,432
2065	Year 38		$ 1,668,162		$ 1,668,162	$ 566,259	18,500	6,280
2066	Year 39		$ 1,668,162		$ 1,668,162	$ 552,826	18,500	6,131
2067	Year 40		$ 1,668,162	$ 615,445	$ 2,283,607	$ 738,829	18,500	5,985
2068	Year 41		$ 1,668,162		$ 1,668,162	$ 526,907	18,500	5,843
2069	Year 42		$ 1,668,162		$ 1,668,162	$ 514,407	18,500	5,705
2070	Year 43		$ 1,668,162		$ 1,668,162	$ 502,203	18,500	5,569
2071	Year 44		$ 1,668,162	$ 80,000	$ 1,748,162	$ 513,802	18,500	5,437
2072	Year 45		$ 1,668,162	$ 1,200	$ 1,669,362	$ 479,002	18,500	5,308
2073	Year 46		$ 1,668,162		$ 1,668,162	$ 467,303	18,500	5,182
2074	Year 47		$ 1,668,162		$ 1,668,162	$ 456,216	18,500	5,059
2075	Year 48		$ 1,668,162		$ 1,668,162	$ 445,393	18,500	4,939
2076	Year 49		$ 1,668,162		$ 1,668,162	$ 434,827	18,500	4,822
2077	Year 50		$ 1,668,162	$ 681,180	$ 2,349,342	$ 597,857	18,500	4,708
2078	Year 51		$ 1,668,162		$ 1,668,162	$ 414,441	18,500	4,596
2079	Year 52		$ 1,668,162		$ 1,668,162	$ 404,609	18,500	4,487
2080	Year 53		$ 1,668,162		$ 1,668,162	$ 395,010	18,500	4,381
2081	Year 54		$ 1,668,162		$ 1,668,162	$ 385,639	18,500	4,277
2082	Year 55		$ 1,668,162		$ 1,668,162	$ 376,490	18,500	4,175
2083	Year 56		$ 1,668,162		$ 1,668,162	$ 367,558	18,500	4,076
2084	Year 57		$ 1,668,162		$ 1,668,162	$ 358,839	18,500	3,980
2085	Year 58		$ 1,668,162		$ 1,668,162	$ 350,326	18,500	3,885
2086	Year 59		$ 1,668,162		$ 1,668,162	$ 342,015	18,500	3,793
2087	Year 60		$ 1,668,162	$ 801,145	$ 2,469,307	$ 494,259	18,500	3,703
2088	Year 61		$ 1,668,162		$ 1,668,162	$ 325,980	18,500	3,615
2089	Year 62		$ 1,668,162		$ 1,668,162	$ 318,246	18,500	3,529
2090	Year 63		$ 1,668,162		$ 1,668,162	$ 310,696	18,500	3,446
2091	Year 64		$ 1,668,162		$ 1,668,162	$ 303,326	18,500	3,364
2092	Year 65		$ 1,668,162		$ 1,668,162	$ 296,130	18,500	3,284
2093	Year 66		$ 1,668,162	$ 80,000	$ 1,748,162	$ 302,969	18,500	3,206
2094	Year 67		$ 1,668,162		$ 1,668,162	$ 282,246	18,500	3,130
2095	Year 68		$ 1,668,162		$ 1,668,162	$ 275,550	18,500	3,056
2096	Year 69		$ 1,668,162		$ 1,668,162	$ 269,013	18,500	2,983
2097	Year 70		$ 1,668,162	$ 51,180	$ 1,719,342	$ 270,689	18,500	2,913
2098	Year 71		$ 1,668,162		$ 1,668,162	$ 256,400	18,500	2,843
2099	Year 72		$ 1,668,162		$ 1,668,162	$ 250,318	18,500	2,776
2100	Year 73		$ 1,668,162		$ 1,668,162	$ 244,379	18,500	2,710
2101	Year 74		$ 1,668,162		$ 1,668,162	$ 238,582	18,500	2,646
2102	Year 75		$ 1,668,162	$ 631,200	$ 2,299,362	$ 321,055	18,500	2,583
2103	Year 76		$ 1,668,162		$ 1,668,162	$ 227,396	18,500	2,522
2104	Year 77		$ 1,668,162		$ 1,668,162	$ 222,001	18,500	2,462
2105	Year 78		$ 1,668,162		$ 1,668,162	$ 216,735	18,500	2,404
2106	Year 79		$ 1,668,162		$ 1,668,162	$ 211,593	18,500	2,347
2107	Year 80		$ 1,668,162	$ 615,445	$ 2,283,607	$ 282,786	18,500	2,291
2108	Year 81		$ 1,668,162		$ 1,668,162	$ 201,673	18,500	2,237
2109	Year 82		$ 1,668,162		$ 1,668,162	$ 196,888	18,500	2,184
2110	Year 83		$ 1,668,162		$ 1,668,162	$ 192,217	18,500	2,132
2111	Year 84		$ 1,668,162		$ 1,668,162	$ 187,657	18,500	2,081
2112	Year 85		$ 1,668,162		$ 1,668,162	$ 183,205	18,500	2,032
2113	Year 86		$ 1,668,162		$ 1,668,162	$ 178,859	18,500	1,984
2114	Year 87		$ 1,668,162		$ 1,668,162	$ 174,616	18,500	1,936
2115	Year 88		$ 1,668,162	$ 80,000	$ 1,748,162	$ 178,649	18,500	1,891
2116	Year 89		$ 1,668,162		$ 1,668,162	$ 166,429	18,500	1,846
2117	Year 90		$ 1,668,162	$ 236,880	$ 1,905,042	$ 185,553	18,500	1,802
2118	Year 91		$ 1,668,162		$ 1,668,162	$ 158,626	18,500	1,759
2119	Year 92		$ 1,668,162		$ 1,668,162	$ 154,863	18,500	1,717
2120	Year 93		$ 1,668,162		$ 1,668,162	$ 151,189	18,500	1,677
2121	Year 94		$ 1,668,162		$ 1,668,162	$ 147,603	18,500	1,637
2122	Year 95		$ 1,668,162		$ 1,668,162	$ 144,101	18,500	1,598
2123	Year 96		$ 1,668,162		$ 1,668,162	$ 140,682	18,500	1,560
2124	Year 97		$ 1,668,162		$ 1,668,162	$ 137,345	18,500	1,523
2125	Year 98		$ 1,668,162		$ 1,668,162	$ 134,087	18,500	1,487
2126	Year 99		$ 1,668,162		$ 1,668,162	$ 130,906	18,500	1,452
2127	Year 100		$ 1,668,162	$ 1,245,445	$ 2,913,607	$ 223,215	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
244	179

Portfolio 4: Extension into San Francisco Bay and Extension to Guadalupe Slough

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Constructio	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	20000	2%	$ 400
		Total Consumables	$ 400.00

Operator Costs	
Pipelength	48,323
Operator Salary/hr	$ 163.20
Yearly Cost	$ 78,863.14

Electricity Costs	
2025	34,360
2035	51,679

Treatment Costs	
2025	1,301,966
2035	1,537,220

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	2,500,000	100	25	25%					$ 625,000	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	7,541,615	100	20	4%			$ 301,665			
Valves	184,500	30	-	-						$ 184,500
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	8,000	15	-	-		$ 1,200				
Pumps (Process/Product)	153,700	20	10	30%	$ 46,110		$ 153,700			
Motors	16,900	20	10	30%	$ 5,070		$ 16,900			
Flow Meters	12,000	20	-	-			$ 12,000			
Diffuser	2,000,000	100	20	4%			$ 80,000			
Above grade concrete	20,000	100	25	25%					$ 5,000	
MCC	80,000	22	-	-				$ 80,000		
Evaporation Pond Liner		10	-	-						
				Totals	$ 51,180	$ 1,200	$ 564,265	$ 80,000	$ 630,000	$ 184,500

Portfolio 4: Deep Water Discharge and Extension to Guadalupe Slough

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 84,385,000	$ 155,285,774	$ 9,827,432	$ 274,669,865	$ 132,632,232	1,850,000	585,214
30-Yr Lifecycle		$ 84,385,000	$ 46,585,732	$ 2,318,086	$ 139,514,068	$ 106,220,081	555,000	330,384
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 21,096,250			$ 21,096,250	$ 19,164,459		
2025		$ 21,096,250			$ 21,096,250	$ 18,709,811		
2026		$ 21,096,250			$ 21,096,250	$ 18,265,948		
2027		$ 21,096,250			$ 21,096,250	$ 17,832,616		
2028	Year 1		$ 1,552,858		$ 1,552,858	$ 1,281,487	18,500	15,267
2029	Year 2		$ 1,552,858		$ 1,552,858	$ 1,251,086	18,500	14,905
2030	Year 3		$ 1,552,858		$ 1,552,858	$ 1,221,406	18,500	14,551
2031	Year 4		$ 1,552,858		$ 1,552,858	$ 1,192,430	18,500	14,206
2032	Year 5		$ 1,552,858		$ 1,552,858	$ 1,164,141	18,500	13,869
2033	Year 6		$ 1,552,858		$ 1,552,858	$ 1,136,524	18,500	13,540
2034	Year 7		$ 1,552,858		$ 1,552,858	$ 1,109,561	18,500	13,219
2035	Year 8		$ 1,823,521		$ 1,823,521	$ 1,272,047	18,500	12,905
2036	Year 9		$ 1,823,521		$ 1,823,521	$ 1,241,869	18,500	12,599
2037	Year 10		$ 1,823,521	$ 72,900	$ 1,896,421	$ 1,260,877	18,500	12,300
2038	Year 11		$ 1,823,521		$ 1,823,521	$ 1,183,645	18,500	12,008
2039	Year 12		$ 1,823,521		$ 1,823,521	$ 1,155,565	18,500	11,723
2040	Year 13		$ 1,823,521		$ 1,823,521	$ 1,128,151	18,500	11,445
2041	Year 14		$ 1,823,521		$ 1,823,521	$ 1,101,387	18,500	11,174
2042	Year 15		$ 1,823,521	$ 1,200	$ 1,824,721	$ 1,075,966	18,500	10,909
2043	Year 16		$ 1,823,521		$ 1,823,521	$ 1,049,750	18,500	10,650
2044	Year 17		$ 1,823,521		$ 1,823,521	$ 1,024,846	18,500	10,397
2045	Year 18		$ 1,823,521		$ 1,823,521	$ 1,000,533	18,500	10,151
2046	Year 19		$ 1,823,521		$ 1,823,521	$ 976,797	18,500	9,910
2047	Year 20		$ 1,823,521	$ 1,099,286	$ 2,922,807	$ 1,528,504	18,500	9,675
2048	Year 21		$ 1,823,521		$ 1,823,521	$ 931,000	18,500	9,445
2049	Year 22		$ 1,823,521	$ 120,000	$ 1,943,521	$ 968,726	18,500	9,221
2050	Year 23		$ 1,823,521		$ 1,823,521	$ 887,351	18,500	9,002
2051	Year 24		$ 1,823,521		$ 1,823,521	$ 866,300	18,500	8,789
2052	Year 25		$ 1,823,521	$ 627,500	$ 2,451,021	$ 1,136,783	18,500	8,580
2053	Year 26		$ 1,823,521		$ 1,823,521	$ 825,684	18,500	8,377
2054	Year 27		$ 1,823,521		$ 1,823,521	$ 806,096	18,500	8,178
2055	Year 28		$ 1,823,521		$ 1,823,521	$ 786,973	18,500	7,984
2056	Year 29		$ 1,823,521		$ 1,823,521	$ 768,303	18,500	7,795
2057	Year 30		$ 1,823,521	$ 397,200	$ 2,220,721	$ 913,458	18,500	7,610
2058	Year 31		$ 1,823,521		$ 1,823,521	$ 732,282	18,500	7,429
2059	Year 32		$ 1,823,521		$ 1,823,521	$ 714,909	18,500	7,253
2060	Year 33		$ 1,823,521		$ 1,823,521	$ 697,949	18,500	7,081
2061	Year 34		$ 1,823,521		$ 1,823,521	$ 681,391	18,500	6,913
2062	Year 35		$ 1,823,521		$ 1,823,521	$ 665,226	18,500	6,749
2063	Year 36		$ 1,823,521		$ 1,823,521	$ 649,445	18,500	6,589
2064	Year 37		$ 1,823,521		$ 1,823,521	$ 634,038	18,500	6,432
2065	Year 38		$ 1,823,521		$ 1,823,521	$ 618,996	18,500	6,280
2066	Year 39		$ 1,823,521		$ 1,823,521	$ 604,311	18,500	6,131
2067	Year 40		$ 1,823,521	$ 1,099,286	$ 2,922,807	$ 945,634	18,500	5,985
2068	Year 41		$ 1,823,521		$ 1,823,521	$ 575,979	18,500	5,843
2069	Year 42		$ 1,823,521		$ 1,823,521	$ 562,314	18,500	5,705
2070	Year 43		$ 1,823,521		$ 1,823,521	$ 548,974	18,500	5,569
2071	Year 44		$ 1,823,521	$ 120,000	$ 1,943,521	$ 571,220	18,500	5,437
2072	Year 45		$ 1,823,521	$ 1,200	$ 1,824,721	$ 523,580	18,500	5,308
2073	Year 46		$ 1,823,521		$ 1,823,521	$ 510,823	18,500	5,182
2074	Year 47		$ 1,823,521		$ 1,823,521	$ 498,705	18,500	5,059
2075	Year 48		$ 1,823,521		$ 1,823,521	$ 486,874	18,500	4,939
2076	Year 49		$ 1,823,521		$ 1,823,521	$ 475,323	18,500	4,822
2077	Year 50		$ 1,823,521	$ 700,400	$ 2,523,921	$ 642,284	18,500	4,708
2078	Year 51		$ 1,823,521		$ 1,823,521	$ 453,038	18,500	4,596
2079	Year 52		$ 1,823,521		$ 1,823,521	$ 442,290	18,500	4,487
2080	Year 53		$ 1,823,521		$ 1,823,521	$ 431,798	18,500	4,381
2081	Year 54		$ 1,823,521		$ 1,823,521	$ 421,554	18,500	4,277
2082	Year 55		$ 1,823,521		$ 1,823,521	$ 411,553	18,500	4,175
2083	Year 56		$ 1,823,521		$ 1,823,521	$ 401,790	18,500	4,076
2084	Year 57		$ 1,823,521		$ 1,823,521	$ 392,258	18,500	3,980
2085	Year 58		$ 1,823,521		$ 1,823,521	$ 382,952	18,500	3,885
2086	Year 59		$ 1,823,521		$ 1,823,521	$ 373,867	18,500	3,793
2087	Year 60		$ 1,823,521	$ 1,423,586	$ 3,247,107	$ 649,944	18,500	3,703
2088	Year 61		$ 1,823,521		$ 1,823,521	$ 356,339	18,500	3,615
2089	Year 62		$ 1,823,521		$ 1,823,521	$ 347,885	18,500	3,529
2090	Year 63		$ 1,823,521		$ 1,823,521	$ 339,632	18,500	3,446
2091	Year 64		$ 1,823,521		$ 1,823,521	$ 331,575	18,500	3,364
2092	Year 65		$ 1,823,521		$ 1,823,521	$ 323,709	18,500	3,284
2093	Year 66		$ 1,823,521	$ 120,000	$ 1,943,521	$ 336,826	18,500	3,206
2094	Year 67		$ 1,823,521		$ 1,823,521	$ 308,532	18,500	3,130
2095	Year 68		$ 1,823,521		$ 1,823,521	$ 301,212	18,500	3,056
2096	Year 69		$ 1,823,521		$ 1,823,521	$ 294,067	18,500	2,983
2097	Year 70		$ 1,823,521	$ 72,900	$ 1,896,421	$ 298,567	18,500	2,913
2098	Year 71		$ 1,823,521		$ 1,823,521	$ 280,279	18,500	2,843
2099	Year 72		$ 1,823,521		$ 1,823,521	$ 273,630	18,500	2,776
2100	Year 73		$ 1,823,521		$ 1,823,521	$ 267,139	18,500	2,710
2101	Year 74		$ 1,823,521		$ 1,823,521	$ 260,801	18,500	2,646
2102	Year 75		$ 1,823,521	$ 628,700	$ 2,452,221	$ 342,398	18,500	2,583
2103	Year 76		$ 1,823,521		$ 1,823,521	$ 248,574	18,500	2,522
2104	Year 77		$ 1,823,521		$ 1,823,521	$ 242,677	18,500	2,462
2105	Year 78		$ 1,823,521		$ 1,823,521	$ 236,920	18,500	2,404
2106	Year 79		$ 1,823,521		$ 1,823,521	$ 231,299	18,500	2,347
2107	Year 80		$ 1,823,521	$ 1,099,286	$ 2,922,807	$ 361,940	18,500	2,291
2108	Year 81		$ 1,823,521		$ 1,823,521	$ 220,455	18,500	2,237
2109	Year 82		$ 1,823,521		$ 1,823,521	$ 215,225	18,500	2,184
2110	Year 83		$ 1,823,521		$ 1,823,521	$ 210,119	18,500	2,132
2111	Year 84		$ 1,823,521		$ 1,823,521	$ 205,134	18,500	2,081
2112	Year 85		$ 1,823,521		$ 1,823,521	$ 200,268	18,500	2,032
2113	Year 86		$ 1,823,521		$ 1,823,521	$ 195,517	18,500	1,984
2114	Year 87		$ 1,823,521		$ 1,823,521	$ 190,878	18,500	1,936
2115	Year 88		$ 1,823,521	$ 120,000	$ 1,943,521	$ 198,613	18,500	1,891
2116	Year 89		$ 1,823,521		$ 1,823,521	$ 181,929	18,500	1,846
2117	Year 90		$ 1,823,521	$ 397,200	$ 2,220,721	$ 216,301	18,500	1,802
2118	Year 91		$ 1,823,521		$ 1,823,521	$ 173,399	18,500	1,759
2119	Year 92		$ 1,823,521		$ 1,823,521	$ 169,286	18,500	1,717
2120	Year 93		$ 1,823,521		$ 1,823,521	$ 165,270	18,500	1,677
2121	Year 94		$ 1,823,521		$ 1,823,521	$ 161,349	18,500	1,637
2122	Year 95		$ 1,823,521		$ 1,823,521	$ 157,521	18,500	1,598
2123	Year 96		$ 1,823,521		$ 1,823,521	$ 153,784	18,500	1,560
2124	Year 97		$ 1,823,521		$ 1,823,521	$ 150,136	18,500	1,523
2125	Year 98		$ 1,823,521		$ 1,823,521	$ 146,574	18,500	1,487
2126	Year 99		$ 1,823,521		$ 1,823,521	$ 143,097	18,500	1,452
2127	Year 100		$ 1,823,521	$ 1,726,786	$ 3,550,307	$ 271,993	18,500	1,417

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
322	227

Portfolio 4: Deep Water Discharge and Extension to Guadalupe Slough

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	20000	2%	$ 400
		Total Consumables	$ 400.00

Operator Costs	
Pipelength	103,017
Operator Salary/hr	$ 163.20
Yearly Cost	$ 168,123.74

Electricity Costs	
2025	82,368
2035	117,777

Treatment Costs	
2025	1,301,966
2035	1,537,220

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank	2,500,000	100	25	25%					$ 625,000	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	18,784,660	100	20	4%			$ 751,386			
Valves	323,100	30	-	-						$ 323,100
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	8,000	15	-	-		$ 1,200				
Pumps (Process/Product)	214,400	20	10	30%	$ 64,320		$ 214,400			
Motors	28,600	20	10	30%	$ 8,580		$ 28,600			
Flow Meters	12,000	20	-	-			$ 12,000			
Diffuser	500,000	100	20	4%			$ 20,000			
Above grade concrete	10,000	100	25	25%					$ 2,500	
MCC	120,000	22	-	-				$ 120,000		
Evaporation Pond Liner		10	-	-						
				Totals	$ 72,900	$ 1,200	$ 1,026,386	$ 120,000	$ 627,500	$ 323,100

Morgan Hill: Evaporation Pond in Gilroy

Year	Operations Year #	Estimated Costs (January 2020 Dollars)				2020 Present Value Cost	Water Supply System Yield (AF)	2020 Present Value Yield (AF)
		Capital Costs	O&M Cost	R&R	Total Cost			
100-Yr Lifecycle		$ 50,476,000	$ 9,884,920	$ 2,252,723	$ 62,585,464	$ 47,931,989	235,000	74,032
30-Yr Lifecycle		$ 50,476,000	$ 2,965,476	$ 526,795	$ 53,961,302	$ 46,270,311	70,500	41,968
2020					$ -			
2021					$ -			
2022					$ -			
2023					$ -			
2024		$ 12,619,000			$ 12,619,000	$ 11,463,474		
2025		$ 12,619,000			$ 12,619,000	$ 11,191,520		
2026		$ 12,619,000			$ 12,619,000	$ 10,926,018		
2027		$ 12,619,000			$ 12,619,000	$ 10,666,814		
2028	Year 1		$ 98,849		$ 98,849	$ 81,575	2,350	1,939
2029	Year 2		$ 98,849		$ 98,849	$ 79,640	2,350	1,893
2030	Year 3		$ 98,849		$ 98,849	$ 77,750	2,350	1,848
2031	Year 4		$ 98,849		$ 98,849	$ 75,906	2,350	1,805
2032	Year 5		$ 98,849		$ 98,849	$ 74,105	2,350	1,762
2033	Year 6		$ 98,849		$ 98,849	$ 72,347	2,350	1,720
2034	Year 7		$ 98,849		$ 98,849	$ 70,631	2,350	1,679
2035	Year 8		$ 98,546		$ 98,546	$ 68,744	2,350	1,639
2036	Year 9		$ 98,546		$ 98,546	$ 67,113	2,350	1,600
2037	Year 10		$ 98,546	$ 18,450	$ 116,996	$ 77,788	2,350	1,562
2038	Year 11		$ 98,546		$ 98,546	$ 63,966	2,350	1,525
2039	Year 12		$ 98,546		$ 98,546	$ 62,449	2,350	1,489
2040	Year 13		$ 98,546		$ 98,546	$ 60,967	2,350	1,454
2041	Year 14		$ 98,546		$ 98,546	$ 59,521	2,350	1,419
2042	Year 15		$ 98,546	$ 600	$ 99,146	$ 58,463	2,350	1,386
2043	Year 16		$ 98,546		$ 98,546	$ 56,730	2,350	1,353
2044	Year 17		$ 98,546		$ 98,546	$ 55,384	2,350	1,321
2045	Year 18		$ 98,546		$ 98,546	$ 54,071	2,350	1,289
2046	Year 19		$ 98,546		$ 98,546	$ 52,788	2,350	1,259
2047	Year 20		$ 98,546	$ 329,145	$ 427,691	$ 223,664	2,350	1,229
2048	Year 21		$ 98,546		$ 98,546	$ 50,313	2,350	1,200
2049	Year 22		$ 98,546	$ 30,000	$ 128,546	$ 64,072	2,350	1,171
2050	Year 23		$ 98,546		$ 98,546	$ 47,954	2,350	1,144
2051	Year 24		$ 98,546		$ 98,546	$ 46,816	2,350	1,116
2052	Year 25		$ 98,546	$ 2,500	$ 101,046	$ 46,865	2,350	1,090
2053	Year 26		$ 98,546		$ 98,546	$ 44,621	2,350	1,064
2054	Year 27		$ 98,546		$ 98,546	$ 43,563	2,350	1,039
2055	Year 28		$ 98,546		$ 98,546	$ 42,529	2,350	1,014
2056	Year 29		$ 98,546		$ 98,546	$ 41,520	2,350	990
2057	Year 30		$ 98,546	$ 146,100	$ 244,646	$ 100,631	2,350	967
2058	Year 31		$ 98,546		$ 98,546	$ 39,574	2,350	944
2059	Year 32		$ 98,546		$ 98,546	$ 38,635	2,350	921
2060	Year 33		$ 98,546		$ 98,546	$ 37,718	2,350	899
2061	Year 34		$ 98,546		$ 98,546	$ 36,824	2,350	878
2062	Year 35		$ 98,546		$ 98,546	$ 35,950	2,350	857
2063	Year 36		$ 98,546		$ 98,546	$ 35,097	2,350	837
2064	Year 37		$ 98,546		$ 98,546	$ 34,264	2,350	817
2065	Year 38		$ 98,546		$ 98,546	$ 33,452	2,350	798
2066	Year 39		$ 98,546		$ 98,546	$ 32,658	2,350	779
2067	Year 40		$ 98,546	$ 329,145	$ 427,691	$ 138,373	2,350	760
2068	Year 41		$ 98,546		$ 98,546	$ 31,127	2,350	742
2069	Year 42		$ 98,546		$ 98,546	$ 30,388	2,350	725
2070	Year 43		$ 98,546		$ 98,546	$ 29,668	2,350	707
2071	Year 44		$ 98,546	$ 30,000	$ 128,546	$ 37,781	2,350	691
2072	Year 45		$ 98,546	$ 600	$ 99,146	$ 28,449	2,350	674
2073	Year 46		$ 98,546		$ 98,546	$ 27,606	2,350	658
2074	Year 47		$ 98,546		$ 98,546	$ 26,951	2,350	643
2075	Year 48		$ 98,546		$ 98,546	$ 26,311	2,350	627
2076	Year 49		$ 98,546		$ 98,546	$ 25,687	2,350	613
2077	Year 50		$ 98,546	$ 20,950	$ 119,496	$ 30,409	2,350	598
2078	Year 51		$ 98,546		$ 98,546	$ 24,483	2,350	584
2079	Year 52		$ 98,546		$ 98,546	$ 23,902	2,350	570
2080	Year 53		$ 98,546		$ 98,546	$ 23,335	2,350	556
2081	Year 54		$ 98,546		$ 98,546	$ 22,782	2,350	543
2082	Year 55		$ 98,546		$ 98,546	$ 22,241	2,350	530
2083	Year 56		$ 98,546		$ 98,546	$ 21,713	2,350	518
2084	Year 57		$ 98,546		$ 98,546	$ 21,198	2,350	506
2085	Year 58		$ 98,546		$ 98,546	$ 20,695	2,350	494
2086	Year 59		$ 98,546		$ 98,546	$ 20,204	2,350	470
2087	Year 60		$ 98,546	$ 456,795	$ 555,341	$ 111,158	2,350	459
2088	Year 61		$ 98,546		$ 98,546	$ 19,257	2,350	448
2089	Year 62		$ 98,546		$ 98,546	$ 18,800	2,350	438
2090	Year 63		$ 98,546		$ 98,546	$ 18,354	2,350	427
2091	Year 64		$ 98,546		$ 98,546	$ 17,919	2,350	417
2092	Year 65		$ 98,546		$ 98,546	$ 17,494	2,350	407
2093	Year 66		$ 98,546	$ 30,000	$ 128,546	$ 22,278	2,350	398
2094	Year 67		$ 98,546		$ 98,546	$ 16,674	2,350	388
2095	Year 68		$ 98,546		$ 98,546	$ 16,278	2,350	379
2096	Year 69		$ 98,546		$ 98,546	$ 15,892	2,350	370
2097	Year 70		$ 98,546	$ 18,450	$ 116,996	$ 18,420	2,350	361
2098	Year 71		$ 98,546		$ 98,546	$ 15,147	2,350	353
2099	Year 72		$ 98,546		$ 98,546	$ 14,787	2,350	344
2100	Year 73		$ 98,546		$ 98,546	$ 14,437	2,350	336
2101	Year 74		$ 98,546		$ 98,546	$ 14,094	2,350	328
2102	Year 75		$ 98,546	$ 3,100	$ 101,646	$ 14,193	2,350	320
2103	Year 76		$ 98,546		$ 98,546	$ 13,433	2,350	313
2104	Year 77		$ 98,546		$ 98,546	$ 13,115	2,350	305
2105	Year 78		$ 98,546		$ 98,546	$ 12,804	2,350	298
2106	Year 79		$ 98,546		$ 98,546	$ 12,500	2,350	291
2107	Year 80		$ 98,546	$ 329,145	$ 427,691	$ 52,962	2,350	284
2108	Year 81		$ 98,546		$ 98,546	$ 11,914	2,350	277
2109	Year 82		$ 98,546		$ 98,546	$ 11,631	2,350	271
2110	Year 83		$ 98,546		$ 98,546	$ 11,355	2,350	264
2111	Year 84		$ 98,546		$ 98,546	$ 11,086	2,350	258
2112	Year 85		$ 98,546		$ 98,546	$ 10,823	2,350	252
2113	Year 86		$ 98,546		$ 98,546	$ 10,566	2,350	246
2114	Year 87		$ 98,546		$ 98,546	$ 10,315	2,350	240
2115	Year 88		$ 98,546	$ 30,000	$ 128,546	$ 13,136	2,350	234
2116	Year 89		$ 98,546		$ 98,546	$ 9,832	2,350	229
2117	Year 90		$ 98,546	$ 146,100	$ 244,646	$ 23,829	2,350	223
2118	Year 91		$ 98,546		$ 98,546	$ 9,371	2,350	218
2119	Year 92		$ 98,546		$ 98,546	$ 9,148	2,350	213
2120	Year 93		$ 98,546		$ 98,546	$ 8,931	2,350	208
2121	Year 94		$ 98,546		$ 98,546	$ 8,720	2,350	203
2122	Year 95		$ 98,546		$ 98,546	$ 8,513	2,350	198
2123	Year 96		$ 98,546		$ 98,546	$ 8,311	2,350	193
2124	Year 97		$ 98,546		$ 98,546	$ 8,114	2,350	189
2125	Year 98		$ 98,546		$ 98,546	$ 7,921	2,350	184
2126	Year 99		$ 98,546		$ 98,546	$ 7,733	2,350	180
2127	Year 100		$ 98,546	$ 331,645	$ 430,191	$ 32,957	2,350	176

Life Cycle Cost (30 years)	Life Cycle Cost (100 years)
1103	647

Morgan Hill: Evaporation Pond in Gilroy

O&M COSTS

Consumables			
	Raw Construction Cost	Percentage of Raw Construction Cost	Cost
Electrical		0%	$ -
Equipment		0%	$ -
Mechanical		0%	$ -
Instrumentation and Controls	10000	2%	$ 200
		Total Consumables	$ 200.00

Operator Costs	
Pipelength	58,600
Operator Salary/hr	$ 163.20
Yearly Cost	$ 95,635.20

Electricity Costs	
2025	3,014
2035	2,711

Treatment Costs	
2025	-
2035	-

R&R COSTS

R&R					Cycle					
Elements	Cost	Replacement Cycle (years)	Refurbishment Cycle (years)	Renewal Costs (percent)	10 years	15 years	20 years	22 years	25 years	30 years
Concrete Holding Tank		100	25	25%					$ -	
Epoxy Coating		20	10	30%						
Conveyance Pipeline (HDPE)	6079867	100	20	4%			$ 243,195			
Valves	127050	30	-	-						$ 127,050
Electrical Equipment & Acc		25	-	-					$ -	
Instrumentation	4000	15	-	-		$ 600				
Pumps (Process/Product)	55900	20	10	30%	$ 16,770		$ 55,900			
Motors	5600	20	10	30%	$ 1,680		$ 5,600			
Flow Meters	6000	20	-	-			$ 6,000			
Diffuser		100	20	4%			$ -			
Above grade concrete	10000	100	25	25%					$ 2,500	
MCC	30000	22	-	-				$ 30,000		
Evaporation Pond Liner	8845000	10	-	-						
				Totals	$ 18,450	$ 600	$ 310,695	$ 30,000	$ 2,500	$ 127,050

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